University of La Verne
Physics Program Review

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Physics Program Review

Executive Summary

The Physics Program at the University of La Verne is one of the programs that comprise the Department of Math/Physics/Computer Science. Students in the program may pursue either a B. A. or a B.S. in the Program. The Program requires students to complete supportive requirements, core requirements, a senior project and a comprehensive exam. The Program has two full-time faculty members and several adjunct faculty members. Currently, the Program graduates 1-2 students per year. During 2000 and 2001 the Physics Program delivered 943 and 828 credit hours, respectively. The Physics Program serves other programs on campus such as general education, Chemistry, Biology, and Computer Science.

The goals of the Physics Program are as follows:
1. Students are prepared for teaching, industry-related occupations and graduate study
2. Students demonstrate use of the scientific method in physics using modern, functional equipment
3. Students demonstrate understanding of general principles in physics such as the conservation laws, the structure of matter, and concepts of motion and energy

The assessment procedures included a comprehensive exam, evaluation of senior projects, assessment of the status of alumni, comparison of ULV curriculum with other comparable colleges and external review.

Highlights of findings are as follows:
1. Graduating students pass all the sections of the comprehensive exam
2. A number of alumni enter graduate study
3. Senior project evaluations demonstrate application of the scientific method
4. The curriculum is mostly comparable with mainline physics programs with a need to add advanced laboratory experience and differential equations
5. Students appear to be very satisfied with the curriculum and interactions with faculty

Highlights of action recommendations:
1. Grow the number of majors in physics
2. Add advanced laboratory and differential equations courses
3. Develop and promote a minor in physics
4. Increase the sense of community among the students in the program
5. Increase the number of certain Laboratory equipment to make lab sessions more efficient

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Introduction

This document presents an overview of the Physics Program at the University of La Verne. The physics program, which includes two full-time physics faculty, is one of the programs which comprise the Department of Math/Physics/Computer Science. The program director, Sarah D. Johnson has been at the University of La Verne (ULV) for over five years. Her field of specialization is experimental particle physics. David Chappell, whose research field is theoretical astrophysics, is starting his third year at ULV. Curriculum Vitae for the physics faculty are contained in Appendix A. Students in the program may pursue either a B.A. or a B.S. in Physics. Currently 1-2 students per year graduate with a physics major from the University of La Verne. Included within the main body of this self-study document are the physics program mission statement, the fall 2001 physics program strategic plan, a review of the program's curriculum and an overall review of the program.

Physics Program Mission Statement

Physics is a core science area, with at least one year of college physics required as a supporting course for students studying almost all of the other pure or applied sciences or mathematics. It is also part of the common base of knowledge which all college educated persons should be familiar with.

Physics has always been an integral part of the liberal arts, and its general principles, such as the conservation laws, the structure of matter, and concepts of motion and energy, are essential to an understanding and appreciation of the world in which we live. Physics is often considered the basic science upon which all other pure or applied scientific fields such as chemistry, biology, medicine or engineering are based.

In the liberal arts oriented courses offered for non-science majors such as Astronomy, Physical Science and Introduction to Physics, as well as in General Physics to a lesser extent, the broad concepts and an appreciation of the subject are emphasized. The student is shown the inherent simplicity and beauty in nature, as well as the impacts these subjects have on our society. The revolution in our thinking and understanding brought about by the application of the scientific method is revisited many times.

In upper level physics courses and Engineering Physics, the student is stretched intellectually and helped to become more disciplined in their study habits by keeping high standards of rigor with an emphasis on problem solving.

By keeping classes small and interacting with students during laboratory time, we allow each student to continually demonstrate their learning, we give motivation when needed, and we encourage them to take responsibility for their own learning. Through independent studies, directed studies and senior projects, physics majors are given ways to show their creativity and become self-motivated.

Students majoring in physics can go into the job market upon graduating, or will be prepared to attend graduate school in physics or related fields. For better preparation for graduate study students are encouraged to complete a second major in chemistry, mathematics or computer science.

This program review is being conducted, in part, to help us evaluate whether our activities align with our stated mission. We aim to indicate throughout this document how our goals and objectives correspond with the mission statement. Our current goals and objectives are laid out in the strategic plan that follows.

Physics Program Strategic Plan - Fall 2001

The physics program will offer students high quality preparation for careers in teaching, in technology related industry, and for graduate school. Appropriate general education courses for the non-science majors and service courses supporting other majors will be offered. The curriculum, while concentrating on the general physics and engineering physics courses with laboratory, will also include general education courses in astronomy, introduction to physics, and physical science and intermediate and advanced level physics courses for majors and those students majoring in related fields such as chemistry, computer science, and mathematics.

Five Year Goals:

1. Both day and evening classes in General Physics and/or Engineering Physics will be offered to accommodate CAPA and traditional age students. Engineering physics will be offered on a yearly basis.

2. Students will have access to more kinds of help in learning through the Wilson Library and the Learning Enhancement Center: tutoring, electronic aids (CD-ROM, etc.), Internet, expanded journal and book collections, videos.

3. Internship programs will be available.

4. Student enrollment will be large enough to offer at least one intermediate or advanced level physics course taught in the classroom each semester.

5. The laboratory time put in by the instructor will receive full workload credit; time will be available to do advising, committee work, help students individually, and to carry on a small research program.

6. Students and faculty will make greater use of the Internet in teaching and communicating course assignments, suggesting reference materials, turning in homework, and researching relevant topics.

7. Faculty will have adequate laboratory space for advanced laboratory courses and faculty/student research. In particular, we will have space for the optical tables and equipment acquired from the Optical Engineering Program of the AAIC.

8. Recruit more quality students interested in the physics major, minor, or in the physical science teaching waiver program.

9. Laboratory experiments will be performed using modern, functional equipment. In particular, five more atomic and nuclear physics experiments will be added to the existing Atomic and Nuclear course to make it a laboratory course and the laboratory equipment for NASC 102 Physical Science will be upgraded.

10. Improve the department's presence on and use of the World Wide Web.

11. Have Engineering Physics required by more majors to increase the enrollment.

12. Introduce an intermediate level course in Math Methods in Physics and require it of our physics majors.

13. Expand astronomy facilities and equipment for senior research opportunities, physical science courses, astronomy courses and public outreach opportunities.

14. Introduce a Special Topics in Physics course.

15. Have separate, dedicated laboratory space for NASC 102L Physical Science Laboratory course and other large physical science GE courses such as Astronomy, Geology and Introduction to Physics.

16. Physics program director will receive extra compensation for extra duties in the form of money or release time.

17. Introduce an Astrophysics course.

18. Modernize the General Physics laboratory to accommodate courses that use computer-based learning experiments.

Specific Objectives to be met in order to attain the stated Goals:

1. Increase the number of majors from the current one-two per year (approximate) to between two and three per year. [Goals 1,4,8]

2. Obtain and maintain state of the art computer equipment with software for both faculty research and to be used in student laboratories. [Goals 2,6,9,10]

3. Obtain modern laboratory equipment for use in both majors and non-majors lab courses, especially NASC 102 Physical Science. [Goal 9]

4. Work with enrollment vice president, admission's office, CAPA, and local high schools to develop contacts and improve recruitment of qualified students. [Goals 4,8]

5. Develop contacts with several local labs/businesses, possibly through former students, that could provide internship opportunities. [Goals 3,8]

6. Maintain two private office spaces and additional laboratory space for research equipment for each faculty member. Find additional office space for emeritus faculty. [Goal 7]

7. Find a larger study room for math/physics students, and equip it with computers, furniture and library materials in good condition. [Goals 2,7]

8. Acquire an additional large laboratory room to be used for physical science labs, other GE courses, advanced laboratory courses, independent study and senior projects. [Goal 7,9,13,15]

9. Improve number and quality of Wilson Library physics and physics related journals, books and videotapes. [Goal 2]

10. In cooperation with the rest of the department, share the services of a lab equipment/computer technician. [Goals 6, 9,10,13]

11. Work more closely with the Learning Enhancement Center in finding tutors etc. [Goal 2]

12. Upgrade the present physics web pages, put more class materials online and make the web a more integral part of course structure. [Goal 10]

13. Encourage other majors to require and/or strongly recommend that their students take Engineering Physics instead of General Physics. [Goal 1, 11]

14. Develop a Math Methods in Physics course and submit the necessary catalog changes to require it of the majors. [Goal 12]

15. Construct a permanent mount for the Meade 10" telescope on the roof of Mainiero. Acquire a solar telescope and spectroscope for use in astronomy and earth science labs.
Explore possibilities of constructing and funding an off-site observatory. [Goal 13]

16. Write and submit a course description for a Special Topics in Physics course. [Goal 14]

17. Change college policy in regards to compensation of program directors. [Goal 16]

18. Write and submit a course description for an Astrophysics course. [Goal 17]

19. Acquire a permanent computer projection system, two additional lab tables, and additional software and data acquisition hardware for student workstations. [Goal 18]

Resources Needed: (by objective number)

1. Time and money to publicize our department, attend local conferences and recruit students interested in physics from local high schools and community colleges. Time and/or manpower to improve the department's web page. Money to offer scholarships for physics majors.

2. An annual budget to maintain and upgrade existing computer equipment in faculty offices and in laboratories. A lab/computer technician to maintain the equipment.

3. An annual budget to purchase new lab equipment and upgrade existing experiments. A lab/computer technician to maintain the equipment.

4. Time and a modest budget for faculty to develop a recruitment plan, make outside visits, design new physics brochure and invite prospective students to campus.

5. Time and help to develop local contacts with jobs or businesses that would participate in an internship program. This might be in cooperation with math, computer science, or chemistry, since a qualified student might not always be available.

6. More office space for the emeritus faculty, a larger space for a student study room, and possibly additional space elsewhere.

7. Space and money to upgrade furnishings and reading materials.

8. A second large laboratory room in addition to MA60 and money to equip it sufficiently.

9. Work closely with Wilson Library staff to upgrade collection related to physics. Increase budget by about $1500 per year.

10. Work with the math/physics/computer science dept. in supporting the addition of a lab/computer technician. Money to fund our portion of the salary.

11. Time to coordinate and plan with the Learning Enhancement Center. More money to pay tutors.

12. Time to devote to this task, possibly with the help of a knowledgeable work-study student or new lab/computer technician.

13. Time to discuss this option with other departments.

14. Time to write up course description and develop course.

15. Money to purchase solar telescope, spectroscope and materials to construct mount on roof.

16. Time to write up course description.

17. Money to pay for additional compensation or release time.

18. Time to write up course description and develop course.

19. Money to purchase all of the necessary equipment.

Curriculum Review

A small study was completed in the summer of 2002 in which we compared the curriculum for a Bachelor of Science in Physics at the University of La Verne(ULV) with similar programs at other institutions. We chose to compare our program's curriculum (see Table 1) with the programs of study of five other physics departments that are similar in size to our program in terms of number of physics majors and/or physics faculty. These five institutions are Azusa Pacific University, California State University at Dominguez Hills, Canisius College, Houghton College, and the University of Redlands. We examined all of the coursework required to complete a B.S. in physics including both physics courses and supporting courses. The data from this study can be seen in Tables 2 and 3.

The results of this study will be very useful as we continue to update our program. Overall, the total number of units (or credit hours) required for a major in Physics at ULV is comparable to the other institutions. ULV requires 63 units out of a total of 128 units required for graduation. The lowest requirement was at Houghton where they only require 57/124 units and the highest was Redlands with 80/120 units. In terms of the number of units of required physics courses, our program is again similar to those in the comparison group. ULV requires 46 units, including the 4 units of Science Seminar and 4 units of Senior Project, where the range was from 38-49 units. On paper, we allow for flexibility in the physics curriculum by allowing for 12 units of physics electives, though in reality the courses we generally offer as electives correspond to those required by the other programs. The only program that includes more elective units is Houghton's.

One major difference between our program and almost all of the others is the lack of a requirement of an advanced physics laboratory. In place of this requirement, ULV has a required senior research project that constitutes four units of work. Azusa Pacific University offers students a choice between an advanced laboratory course taken at another university or a senior project course. We are currently upgrading our laboratory facilities and hope in the near future to be able to offer such a course. In the meantime, we have been trying to include some laboratory experiments within our upper division physics courses such as Optics and Atomic and Nuclear Physics. In addition, the physics elective, PHYS 311 Electronics for Scientists, is taught as a primarily laboratory course and CHEM 411 Physical Chemistry, which can be used as a physics elective, is a laboratory course.

Discrepancies between the physics program at ULV and the other programs also occur when you compare the required courses in mathematics and computer science. Four out of five of the major programs in the comparison group require students to take a mathematics course in Differential Equations. This course is not currently required for

the physics major at ULV though we strongly recommend that students take it. After having done this study, it seems that we should consider adding it to our program as a required supporting course. A similar situation is true for an introductory computer programming course, which eighty percent of the comparison group require. Again, we often recommend that students take such a course, and our dual physics-math majors are required to for the math major, but it is not currently a required course in the curriculum. Because we currently require fewer units of supporting coursework than all of the comparison group programs it seems reasonable that we should add these two courses to the physics major requirements.

Overall Program Review

a. Course Offerings for the University as a Whole

The physics program offers a broad range of supporting courses for science majors in fields other than physics, and survey courses for non-science majors. Appendix B contains copies of the syllabi for the courses discussed below.

Non-Science Major Courses

Courses geared to non-science majors include Introduction to Physics, Astronomy, and Physical Science. These courses all satisfy the general education requirement for physical science. They are each offered at least once per year and typically have large enrollments (see Table 5). The physical science sequence is a requirement for the Liberal Studies major. Expansion of the physical science sequence from one to two semesters was required in order for the liberal studies major to comply with the California Commission on Teacher Credentialing. Next spring will be the first time the first course in the two-semester sequence will be offered. Over the last five years, 40 non-science major courses have been taught, drawing an average of 148 students per year (see Table 5).

Supportive Courses for Other Sciences

The Chemistry, Biology, and the Computer Science major, with a concentration in engineering or software, require the two-semester algebra-based General Physics sequence. (The two semester calculus-based Engineering Physics sequence may be taken as an alternative and is recommended for those who have had some calculus.) Computer science majors with a concentration in information science or web computing are required to take only one semester of the General Physics sequence. The Math major began requiring the calculus-based Engineering Physics sequence in the fall of 2001. In past years, the Engineering Physics course had often been offered only as a directed study due to small enrollments. Students registered for Engineering Physics as a directed study would typically attend the General Physics lectures and an additional hour-long session in which calculus was used. Beginning in the fall of 2002 Engineering Physics will again be offered as a separate course. At the time of this writing, ten students are enrolled for the fall 2002 Engineering Physics class. Over the last five years an average of 29 and 23 students have taken the fall and spring semesters of the General Physics sequence each year. The Engineering Physics sequence saw an average of 4 and 2 students per year (see

Table 5). Since the math major is now requiring Engineering Physics, we expect enrollments to increase over the next few years.

b. Course Offerings for Physics Majors

Over the last five years three students have graduated with a bachelors degree in physics from ULV. One out of the three students received a double major in physics and math. At present four students are declared as physics majors.

Tables 1 and 5 list the upper-division courses offered by the physics program. The core courses required for all physics majors are also indicated. Table 4 shows a representative program of study for a physics major. As discussed above, the core requirements are typical of those for a small university. In addition to the courses listed in the table, specialty courses are also offered as independent studies depending on student interest. For example, last year an astrophysics course was offered as a physics elective. The small size of the program has the advantage that students have the opportunity to work with the faculty to tailor their majors according to their interests. The faculty are planning to develop a mathematical methods course and an advanced laboratory course in the future. The core courses and most of the electives are offered approximately every two years depending on student needs.

The physics program has a variety of laboratory facilities. The program offers three lab sections of twelve students for each semester of the lower-division courses PHYS 201/3 and PHYS 202/4. Many of the experiments use Science Workshop for data acquisition. At present, there are six computer lab stations in the General Physics laboratory. However, since we only have two or three set-ups for most stand-alone experiments, several different experiments must be conducted on any given week. We are currently introducing labs into some of our upper-division courses. The only upper-division course at present that includes a substantial laboratory component is the electronics course, PHYS 311. Equipment including an x-ray spectrometer and a gamma-ray detector was purchased recently to introduce experiments into the atomic and nuclear course. Last year we also established a new optics lab with experiments in diffraction and interferometry. We plan on introducing experiments in Fourier optics and holography the next time it is taught.

Approximately half of the upper-division courses are currently taught as directed study. The implication of this practice is that faculty teach an average of at least one upper-division course per year "off-load," meaning that no compensation is provided. The result is that the effective teaching load is actually higher than the official load. For example, one faculty member last year taught a full load of five classes and two labs, but also taught a course as an overload for the Honors Program, taught two additional upper-division physics courses as directed study in addition to supervising two senior research projects. With such heavy teaching loads, faculty are left with little time for research during the academic year.

c. Teaching, Counseling and Advising

The two full-time, tenure-track physics faculty teach General Physics, Engineering Physics, the physics labs, and all the upper-level physics courses. Both of the

full-time faculty members are able to teach all of the courses offered by the physics program, which allows for a great deal of flexibility. Sarah Johnson has eight years of teaching experience at the college level and David Chappell has three years of teaching experience. The full-time faculty members always carry at least a full teaching load of 24 semester hours per year, where laboratories get 3/4 credit for the first section and 1/2 credit for each additional section of the same laboratory taught. The physics program offers one January term course each year which the full-time faculty alternate teaching. Physics faculty also teach courses outside the program such as NASC 370: Science Seminar, HONR 320: Interdisciplinary Honors Seminar III and CORE 340: The Sustainable Planet. This heavy teaching load for the full-time faculty leaves little time for curriculum development, research or administrative tasks.

The majority (65%) of the non-science major courses are taught by adjunct faculty. Each of the full-time physics faculty typically teach one non-science major course per year, typically PHYS 230: Astronomy and PHYS 105: Introduction to Physics. One adjunct faculty member teaches Astronomy several times a year. Two part-time faculty each teach a section of NASC 102 Physical Science in the fall and the spring semesters and often one section in the summer.

Students who choose to major in physics get a great deal of one-on-one advising and counseling due to the low faculty-to-student ratio in the physics program. The advising load is officially divided up among the two full-time faculty, though a lot of informal counseling also occurs in advanced physics courses. Both full-time faculty members remain active in research in different physics sub-fields, which allows students some choice when it comes to senior research projects. Physics faculty also contribute to the summer advising of freshman and transfer students who are interested in majoring in science or mathematics.

d. Success of Graduates

The physics majors who have graduated in the last five years have pursued several different paths:

Annette Villa, who participated in graduation in May 2001, has completed all of her physics major requirements including the senior project and comprehensive exam. She has one outstanding CORE course requirement to be met. She is currently employed in southern California and hopes to attend graduate school in applied mathematics in the near future.

Daniel Kiminki, who graduated in May 2002, has been accepted into the graduate program in Astronomy at the University of Wyoming. He plans to begin his graduate studies this coming Fall.

Phil Consiglio, a CAPA adult student, participated in graduation in May 2002 and expects to have completed all of his graduation requirements by December 2002. He currently runs his own energy systems consulting company, but is contemplating a career change now that he has his bachelor's degree.

e. Leadership by Program Director

It is difficult to evaluate the leadership of the program director in a program with only two faculty. Almost all decisions about the program are made jointly by the two faculty after a consensus has been reached. The Physics program at ULV is a part of the Department of Math/Physics/Computer Science. The chair of this department, Michael Frantz, is responsible for most of the administrative duties such as dealing with the budget and hiring part-time faculty. The program director, Sarah D. Johnson, is responsible for several ongoing administrative tasks which include course scheduling, yearly updating of the strategic plan for physics, supervision of student employees and maintenance of the program web pages. The director is often called upon by the department chair or the university administration to complete other program specific tasks as they occur. The program director receives no additional compensation or load reduction for this work. One drawback of being part of a department that houses three somewhat different disciplines is that our department chair is not an expert on issues unique to physics and so our point of view does not always get accurately represented, by no fault of our department chair, at university meetings that are only attended by chairs of departments.

f. Support Personnel

Both faculty members contribute to the program by setting-up and taking down laboratory equipment, repairing equipment, developing new experiments and demonstrations and ordering equipment and supplies. Each year we try to hire one or two physics majors to aid in these tasks and to answer student questions during General Physics laboratories. This often requires some student training by the faculty every year due to student turnover. It would be a great help to our program to be able to employ a physics laboratory technician. Even ongoing part-time help would be useful. The physics program is the only lab science program at ULV that does not employ any support staff.

The faculty do most of their own clerical tasks such as typing tests or syllabi on their own computers. We make some use of the Natural Science Division secretary for copying papers and putting items on reserve in the library. We also make some use of the newly created Instructional Technology Center for help with both in-class and research presentations. Our computer support is provided by the Office of Information Technology though the faculty also find that they have to provide a lot of their own computer support when this office is unable to solve our problems.

g. Physical Plant, Equipment and Library Facilities

The physics program is housed with the majority of the other science programs in the Maineiro(MA) building. Our facilities consist of two faculty offices MA 64 and MA 152C, the General Physics laboratory room, MA60, two stock rooms MA 62 and MA 58 and a small Optics laboratory in the back half of MA54. There is a small shop in MA 59 that is shared by all of the science programs. We feel our greatest space need is additional laboratory space. MA 60 is only large enough to handle 12 students comfortably in a laboratory setting. In order to conduct laboratory activities with our larger classes, such

as NASC 102L: Physical Science Laboratory, which has a typical enrollment of 20 students, we must use either the General Chemistry laboratory (MA 57) if available or, MA 156, which is used extensively by the Biology department. We also have a need for space to set-up and leave up laboratory experiments for the upper-level physics courses.

The physics program, as mentioned above, is a part of the Department of Math/Physics/Computer Science, therefore equipment purchases are made out of the department budget. Rather than list the budget numbers for the entire department we have chosen to include a table of major (> $250) equipment purchases during the last five years for the physics program alone (See Table 7). There was a major increase in our equipment purchases during 2000/2001 due to a significant change in university policy. The faculty of the physics program, along with all of the science programs, were asked to list all of the equipment they felt were necessary to maintain a viable program and the university has committed to purchasing and maintaining this level of equipment. For the past two years the university has provided a sum of money, which the science programs have divided between themselves for major equipment purchases. Our primary goals in the last two years have been to purchase additional PHYS 201/2L:General Physics Laboratory equipment in order to have enough setups, including spares, so that twelve students can work in pairs on six identical experiments, and to introduce advanced experiments into our upper division physics courses. We still have some way to go before reaching these goals. Apart from this money, the program also receives equipment funds through laboratory fees paid by the students. The program receives 75% of this fee, which is now $100 per student per lab. This money, which accrues from year to year and currently totals about $10,000, is also being spent to reach the above listed goals.

The University of La Verne provides extensive library facilities and a knowledgeable library staff. The on-campus Wilson Library collection contains 995 physics items (code QC) and 481 astronomy items (code QB). This includes books, videos and reference materials. The number of these that are videos is 28 for astronomy and 36 for physics including the complete Mechanical Universe on VHS. The physics program also owns a few (~10-20) of our own videos. The physical journal holdings in the library include Physical Review Letters up until 1989, and Physical Review up until 1968. We have direct access online or via subscription to many of the base physics periodicals including the two mentioned above, Physics Today, American Journal of Physics, Journal of Applied Physics, Industrial Physicist, and Applied Physics Letters. The physics faculty have their own subscriptions to several of these publications as well as Sky and Telescope and The Physics Teacher. The library also maintains online or paper access to many astronomy publications such as Sky and Telescope and Astronomy magazine, and it maintains a relationship with a network of thirteen academic libraries to facilitate efficient interlibrary loan of materials. The physics program plans to conduct an evaluation of the library holdings in physics and astronomy in the near future in order to bring the collection up-to-date.

Table 1: Physics Degree Requirements

Core Requirements:		**Credit Hours**
PHYS 203	Engineering Physics I	(5)
PHYS 204	Engineering Physics II	(5)
PHYS 322	Electricity and Magnetism	(4)
PHYS 342	Analytical Mechanics	(4)
PHYS 360	Atomic and Nuclear Physics	(4)
PHYS 368	Quantum Mechanics	(4)
NASC 370	Science Seminar (4 sem.)	(1,1,1,1)

Electives:

A minimum of 8 semesters hours for the B.A.
A minimum of 12 semester hours for the B.S.

PHYS 311	Electronics for Scientists	(4)
PHYS 350	Optics	(4)
PHYS 355	Thermodynamics	(2)
PHYS 409	Special Topics in Physics	(4)
CHEM 411	Physical Chemistry I	(4)

Supportive Requirements:

CHEM 201	General Chemistry	(4)
MATH 201	Calculus I	(4)
MATH 202	Calculus II	(4)
MATH 211	Calculus III	(4)

Culminating Requirement:

PHYS 499	Senior Project	(1-4)
Comprehensive examination		(0)