PROFESSIONAL SCIENCE MASTER’S IN APPLIED PHYSICS  
(Name Change)

Name of Institution:  Oregon State University  
Name of Proposing College:  Science  
Name of Proposing Program:  Applied Physics  
Date of Proposal:  30 June 2011  
Proposed Effective Term:  Fall 2011

A. Title of the proposed instructional, research, or public service unit. For name changes, give both the current and proposed names. Describe the reason(s) for the proposed change.

Current name: MS in Applied Physics (non-thesis option)  
Proposed name: Professional Science Master’s in Applied Physics

This program has been offered as a non-thesis Professional Science Master’s (PSM) program since 2003. The PSM is a unique program that combines graduate-level education in Science, Technology, Engineering, or Mathematics (STEM) with training in business management, communication, research ethics, and other employer-relevant skills (http://psm.science.oregonstate.edu). Students complete an internship in lieu of thesis research, giving them practical experience in the workplace. There are now over 238 PSM programs offered by 110 institutions across the U.S. (http://sciencemasters.com/). There is a statewide PSM program development project underway involving multiple campuses in the OUS (http://oregonpsm.org). The Oregon University System (OUS) Provosts’ Council and State Board of Higher Education approved the “PSM” as a new degree option in Oregon (http://www.ous.edu/sites/default/files/about/polipro/files/ORPSMGuidelinesNov2010.pdf) on 24 February 2011. Changing the name of the degree will help us brand and promote these unique programs to employer groups, prospective students, and will recognize graduates who’ve completed this education, designed to provide depth of knowledge in STEM disciplines as well as breadth of training in management.

B. Location within the institution’s organizational structure. Include “before” and “after” organizational charts (show reporting lines all the way up to the Provost).

There will be no change in location within OSU’s organizational structure. This degree will offered as an option through the former Applied Physics (PHYS) Program, which is offered through the Department of Physics.

C. Objectives, functions (e.g., instruction, research, public service), and activities of the proposed unit.

1. Explain how the program’s current objectives, functions, and/or activities will be changed. Where applicable, address issues such as course offerings, program requirements, admission requirements, student learning outcomes and experiences, and advising structure and availability. How will the reorganized program be stronger than the existing program?
The former MS option in the Applied Physics Program has recently been terminated; however, a PSM in Applied Physics will now be recognized as a new degree option instead of simply a non-thesis MS option within that program.

Physics is a fundamental scientific discipline stitched together by a physicist’s skills in mathematics, computation, instrumentation and problem solving. With this background, physicists are among the most versatile of scientists. The objective of the PSM in Applied Physics is to train students for a variety of career paths in businesses like energy and communications, in the legal profession, stock market, and other non-traditional areas where success depends on identifying and exploiting new technical knowledge. Industry leaders tell us that our dynamic, technologically-based economy needs scientifically educated generalists -- men and women with the skills of a physicist, who understand fundamental scientific principles, who have the ability to re-educate themselves in a constantly changing technical landscape, and who can effectively communicate across the lines of specialization. The PSM program can usually be completed in two years, based on full-time study and at least 54 credit hours. [http://psm.science.oregonstate.edu/program-curriculum-m-s-applied-physics](http://psm.science.oregonstate.edu/program-curriculum-m-s-applied-physics)

Comparison between the PHYS non-thesis MS and PSM in Applied Physics:

<table>
<thead>
<tr>
<th>MS in Applied Physics</th>
<th>PSM in Applied Physics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core courses (12 credits)</td>
<td>Core courses (12 credits)</td>
</tr>
<tr>
<td>General courses (9 credits)</td>
<td>General &amp; specialty (18 credits)</td>
</tr>
<tr>
<td>Specialty courses (15 credits)</td>
<td>Professional courses (18 credits)</td>
</tr>
<tr>
<td>Project (PH 501; 3) &amp; electives (6 credits)</td>
<td>Internship (MCB 510; 6-12 credits)</td>
</tr>
<tr>
<td>Total: minimum 45 credits</td>
<td>Total: minimum 54 credits</td>
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</table>

The MS in Applied Physics and PSM in Applied Physics share the same core and general courses. Students in the MS program take an additional 15 credits in one of four areas of concentration: optical physics, materials science, computational physics, or environmental physics ([http://physics.orst.edu/MSApplied](http://physics.orst.edu/MSApplied)). Students in the PSM program instead take Advanced Computational Physics Laboratory (PH 517; 3 credits) and one or more electives from an area of concentration (minimum 3 credits).

The core courses for both programs include 12 credits chosen from the following options:

**PH 531. CAPSTONES IN PHYSICS: ELECTROMAGNETISM (3).**
Static electric and magnetic fields in matter, electrodynamics, Maxwell equations, electromagnetic waves, wave guides, dipole radiation. PREREQS: (PH 424 or PH 524) and (PH 426 or PH 526)

**PH 535. CAPSTONES IN PHYSICS: CLASSICAL MECHANICS (3).**
Newtonian, Lagrangian and Hamiltonian formulations of classical mechanics: single-particle motion, collisions, variational methods, and normal coordinate description of coupled oscillators. PREREQS: (PH 424 or PH 524) and (PH 426 or PH 526)

**PH 541. CAPSTONES IN PHYSICS: THERMAL AND STATISTICAL PHYSICS (3).**
Entropy and quantum mechanics; canonical Gibbs probability; ideal gas; thermal radiation; Einstein and Debye lattices; grand canonical Gibbs probability; ideal Fermi and Bose gases; chemical reactions and phase transformations. PREREQS: (PH 423 or PH 523) and (PH 451 or PH 551)
PH 551. CAPSTONES IN PHYSICS: QUANTUM MECHANICS (3).
Wave mechanics, Schroedinger equation, operators, harmonic oscillator, identical particles, atomic fine structure, approximation methods and applications. PREREQS: (PH 424 or PH 524) and (PH 425 or PH 525) and (PH 426 or PH 526)

PH 621. DYNAMICS OF SINGLE- AND MULTI-PARTICLE SYSTEMS (3).
Introduction to theory of non-linear systems. Chaos in Hamiltonian and dissipative systems. Lyapunov exponents, fractal geometries. PREREQS: PH 435 or PH 535 or equivalent.

PH 631, 632, 633. ELECTROMAGNETIC THEORY (3 each).
Electrostatics; multipole expansion; magnetostatics; radiation fields; dynamics of relativistic particles and electromagnetic fields. PREREQS: PH 431 or PH 531 or equivalent. PH 631, PH 632, PH 633 must be taken in order.

PH 641, 642. STATISTICAL THERMOPHYSICS (3 each).
Macroscopic thermodynamics and kinetic theory. Classical and quantal statistical ensembles; partition functions. Applications to atoms and molecules, clustering, solids, radiation. PREREQS: PH 435 or PH 535. PH 641, PH 642 must be taken in order.

PH 651, 652, 653. QUANTUM MECHANICS (3 each).
Basic principles of nonrelativistic quantum theory and applications. Schroedinger theory, quantum theory of angular momentum, matrix mechanics, perturbation theory, identical particles, scattering. PREREQS: (PH 435 or PH 535) and (PH 451 or PH 531) or equivalents. PH 651, PH 652, PH 653 must be taken in order.

General practical training course options are also the same between MS and PSM Applied Physics programs. A minimum of 9 credits chosen from the following options are required for MS students, and course requirements for PSM students are indicated with an asterisk:

*PH 511. ANALOG AND DIGITAL ELECTRONICS (3).
Circuit theory. Passive dc and ac circuits including filters, resonance, complex impedance and Fourier analysis. Operational amplifiers, gates and combinational logic. Semiconductor principles, diodes, transistors, BJT's and FET's. Multiplexing, flip-flops and sequential logic, 555 timer, registers and memory, DAC, ADC. PH 511 and PH 512 must be taken in order.
PREREQS: PH 314

PH 512. ANALOG AND DIGITAL ELECTRONICS (3).
Circuit theory. Passive dc and ac circuits including filters, resonance, complex impedance and Fourier analysis. Operational amplifiers, gates and combinational logic. Semiconductor principles, diodes, transistors, BJT's and FET's. Multiplexing, flip-flops and sequential logic, 555 timer, registers and memory, DAC, ADC. PREREQS: PH 314 and PH 511

*PH 515. COMPUTER INTERFACING AND INSTRUMENTATION (3).
Applications of computers as scientific instruments, with emphasis on hardware and instrumentation, online data acquisition, and computer control of experiments. PREREQS: Upper-division or graduate standing; (PH 412 or PH 512) or equivalent background in electronics; and instructor approval required. Departmental approval required.
PH 564. SCIENTIFIC COMPUTING II (3).
Mathematical, numerical, and conceptual elements forming foundations of scientific computing: computer hardware, algorithms, precision, efficiency, verification, numerical analysis, algorithm scaling, profiling, and tuning. Lec/lab.

*PH 565. COMPUTATIONAL PHYSICS (3).
The use of basic mathematical and numerical techniques in computer calculations leading to solutions for typical physical problems. Topics to be covered include models and applications ranging from classical mechanics and electromagnetism to modern solid state and particle physics. PREREQS: PH 464 or PH 564

*PH 566. COMPUTATIONAL PHYSICS (3).
The use of basic mathematical and numerical techniques in computer calculations leading to solutions for typical physical problems. Topics to be covered include models and applications ranging from classical mechanics and electromagnetism to modern solid state and particle physics. PREREQS: Mathematical physics such as PH 461/PH 561, PH 462/PH 562 or MTH 481/MTH 581, MTH 482/MTH 582, MTH 483/MTH 583, plus knowledge of a compiled language such as Pascal, C, or FORTRAN. A physics background including PH 431/PH 531, PH 435/PH 535, and PH 451/PH 551 is assumed.

*PH 567. ADVANCED COMPUTATIONAL PHYSICS LABORATORY (3).
Realistic, abbreviated research experience using computer simulations from graduate theses and national laboratory research. Uses Web-enhanced and computer-mediated laboratory manual. PREREQS: PH 466 or PH 566

The required professional courses are designed to be taken in sequence during the first academic year and include:

COMM 550. COMMUNICATION AND THE PRACTICE OF SCIENCE (3).
[Pending approval #79896] Course develops a broad range of skills encompassing verbal, written, and visual media styles of communication. Topics include: working in teams and collaborative decision-making; interpersonal and organization communication; writing and making presentations to diverse audiences; negotiation and consensus building; and persuasion and influence in communication.

PHL 547. RESEARCH ETHICS (3). An examination of the interrelationship between ethical values and scientific practice. Topics include professionalism in science; scientific integrity, misconduct, and whistleblowing; the ethics of authorship; conflicts of interest between academic science and commercial science, and social responsibilities in science. Guidelines relating to patent, trademark, copyright, and authorship issues are covered as well.

PSM 513. PROFESSIONAL SKILLS (3). Students work in teams with off-campus mentors to address a contemporary problem in a scientific field within the context of an existing business. This collaborative project will provide students with opportunities to integrate and apply their collective knowledge of business management, communication, and science to create innovative solutions. Project management, team skills, and leadership styles are also covered, and a final report and presentation are usually required. PREREQS: COMM 550 and PHL 547 and PSM 565 and PSM 566 and concurrent enrollment in PSM 567
PSM 565. ACCOUNTING AND FINANCE FOR SCIENTISTS (3). Students develop business management skills by learning principles of managerial and financial accounting and understanding profit and loss statements, cost analysis, and investment risks. Individuals utilize basic financial tools needed to develop business proposals and successful manage scientific projects in public and private work sectors.

PSM 566. PROJECT MANAGEMENT AND MARKETING SCIENTIFIC TECHNOLOGIES (3). Students gain an understanding of marketing principles and global markets with a focus on scientific technologies. Project management skills needed to effectively manage diversity, conflict and change in corporate, government and nonprofit environments as well as entrepreneurial ventures will be emphasized. PREREQS: PSM 565

PSM 567. INNOVATION MANAGEMENT (3). Students learn about different types of innovation, development and implementation of new technologies, and intellectual property. Student teams develop and present business plans as term projects. Structuring small business enterprises, project planning and management, and commercialization of new products and services prepare individuals for leadership roles in the innovation process. PREREQS: PSM 565 AND PSM 566

Students are required to complete a 3 to 6 month internship (6-12 credits) in lieu of thesis research, and many PSM in Applied Physics students complete 6 month internships. Guidelines for development of an internship proposal, evaluation of performance, and final report requirements are available online and help ensure that the internship is a meaningful educational experience (http://psm.science.oregonstate.edu/internships). Students have been hired by a variety of companies as interns, including Hewlett Packard, Hinds Instruments, Inc. NASA Jet Propulsion Laboratory, Photon Kinetics, ViewPlus Technologies, Inc. Wafertech Technologies, Inc., Microsystems Engineering, Inc., and others. Opportunities are posted online (http://oregonpsm.org/internships-and-jobs), and the Oregon PSM Internship Coordinator facilitates placement of students.

Admission requirements are similar to those for other PHYS graduate programs and include a minimum GPA of 3.0 on the last 90 quarter credit hours, completion of a 4-year undergraduate degree in math, science or engineering (courses should include electromagnetism (level of Griffiths), classical mechanics (Marion), thermal physics (Kittel), and quantum physics (Eisberg or Leighton), GRE scores of at least 1,100 combined verbal and analytical, TOEFL scores for international applicants (minimum of 550), a statement of interest, and three letters of recommendation (http://psm.science.oregonstate.edu/admission-applied-physics-program).

Graduates from the PSM in Applied Physics will likely secure careers in industry working in design, development, research, programming, modeling and simulation, and system administration. Because they are not trained as narrow specialists, they will be able to adapt to rapidly changing business and technological conditions. They will also have a basic understanding of business principles, as well as project management and oral and written communication skills, to help them apply their science in a business context.

Students in this PSM program belong to two cohorts, which enhances their graduate experience: 1) classmates enrolled in the PHYS graduate program, and 2) the PSM collective cohort comprised of students from other STEM disciplines (e.g., botany, biotechnology, and environmental sciences). The PSM cohort engages in a variety of activities to help develop group cohesion and increase retention:
A 5-day workshop the week prior to the start of fall term is held at an off-campus facility, and important topics not included elsewhere in the curriculum are covered. Some of these topics include project collaboration in the virtual environment, networking and dining etiquette, and interview and time management skills.

All students complete the 18 credits of professional coursework together during the first academic year (two courses per term).

Social events are regularly scheduled and include a fall gathering event at the beginning of fall term, a student mentorship program, an industry luncheon in early December, monthly seminars featuring off-campus speakers, 1st Friday happy hour gatherings, and an end-of-the-year barbecue picnic with industry representatives.

Students are initially advised by Dr. Ursula Bechert, Director of Off-Campus Programs, Dr. Janet Tate, Director of the Applied Physics Program, and Dr. Kirstin Carroll, PSM Coordinator, and these individuals continue to provide general administrative support to each student enrolled in the program. Like other graduate students, a graduate committee consisting of a major professor and minimum of three members is required for each PSM student (http://psm.science.oregonstate.edu/faculty). These individuals provide advice regarding coursework and approve a Program of Study form, mentor students within their profession, facilitate laboratory rotations or research experiences, provide feedback on and final approval of an internship proposal, check on progress made during the internship, and grade the internship based on review of the student’s internship journal, the employer’s formal review (http://psm.science.oregonstate.edu/internship_evaluation_form), and the final report in lieu of student’s thesis. The internship supervisor provides on-the-job training based on learning outcomes described in the internship proposal.

2. Explain how outcomes in the newly organized program will be assessed.

Student learning is assessed by traditional measures (e.g., performance on written tests and in oral presentations), the internship evaluation, and students are required to undergo a final oral examination to receive their degree. An exit interview is conducted once a student has passed the oral examination to assess the PSM program and student’s perception of learning outcomes. All alumni from the program are tracked to assess post-graduation employment history (http://psm.science.oregonstate.edu/alumni-profiles). There are four alumni of the PSM in Applied Physics, and two students are currently enrolled.

The National Governors Association Center for Best Practices report entitled Degrees for What Jobs? Raising Expectations for Universities and College in a Global Economy (March 2011; http://www.nga.org/Files/pdf/1103DEGREESJOBS.PDF) states, “A growing number of governors and state policymakers have come to recognize that higher education, including community colleges, four-year colleges, and research universities, cannot help drive economic growth in their states unless students’ academic success is linked to the needs of the marketplace.” The report emphasized the importance of encouraging employers’ input in higher education, and the PSM in Applied Physics at OSU has attempted to do this starting with a joint industry-faculty workshop in June 2001. Half of this program’s PSM graduates find employment in Oregon after graduation, demonstrating how the program contributes to regional economic development especially in the semiconductor (microelectronics) and electrical components industry.

D. Resources needed, if any: personnel, FTE academic, FTE classified, facilities and equipment.
No additional resources are needed.

E. **Funding sources: state sources (institutional funds – state general fund, tuition and fees, indirect cost recoveries), federal funds, other funds as specified.**

Funding sources will remain the same.

F. **Relationship of the proposed unit to the institutional mission.**

The PSM in Applied Physics draws on existing faculty expertise in the Department of Physics. This program fits in OSU’s Signature Area of Distinction: Promoting Economic Growth and Social Progress.

The economies of the Pacific Northwest and the U.S. as a whole are increasingly driven by new technology. In Oregon for example, industries such as semiconductor manufacturing, optical and electronic instrumentation, and software have become the dominant employers, replacing lumbering, fishing and other traditional resource-based industries. The semiconductor (microelectronics) and electrical components industry has been growing and contributed $12 billion to Oregon’s gross state product in 1999. Generalists with a solid understanding of fundamental scientific principles and a portable “skill set” that can be applied to new problems in an ever-changing technological environment are needed, and the PSM in Applied Physics addresses that need. Current OSU PSM Advisory Board members representing relevant industries in Oregon include: Chris Beatty, President of Trillium FiberFuels, Inc., Takuji Tsukamoto, President of Chemica Technologies, Inc., and John Ledger, Vice President External Affairs for Associated Oregon Industries.

G. **Long-range goals and plans for the unit (including a statement as to anticipated funding sources for any projected growth in funding needs).**

n/a

H. **Relationship of the proposed unit to programs at other institutions in the state.**

n/a

I. If the program is professionally accredited, identify the accrediting body and discuss how the proposed change may affect accreditation.

n/a

Appendices:
- Transmittal sheet
- Budget table n/a
- Library evaluation n/a
- Liaison