



SACRAMENTO
STATE

Program Proposal Form B



Academic Group: <i>Natural Sciences & Mathematics</i>	Date of Submission to College Dean: October 14, 2009
Academic Organization: <i>Department of Physics & Astronomy</i>	Requested Effective: Spring 2010
Department Chair: <i>Hossein Partovi</i>	Contact if not Department Chair:
Title of the Program: Scientific Computing & Simulation	
Type of Program Proposal: New Certificate Program	
<p>I. BRIEF DESCRIPTION. This is a proposal for establishing a certificate program in Scientific Computing & Simulation (SCS). It requires 8 units of lower-division courses as basic science background, currently required of nearly all science and engineering majors, and two upper-division courses dealing with the basics of computing, simulation, and modeling. It is open to all students, and specifically intended for students in the Colleges of Natural Sciences & Mathematics and Engineering & Computer Science. This program may be characterized as providing the basics of electronic calculation, simulation, and modeling which supplement our traditional lower-division physics and mathematics education in the two colleges.</p> <p>II. JUSTIFICATION. Electronic simulation, modeling, and computing today encompass a broad range of applications, from the problems of production engineering to the simulation of new chemical compounds and materials, mapping genetic codes to models of self-producing molecules and life, the subatomic world of high energy to the cosmic realm of galaxies, intricate details of financial engineering to the abstract problems of mathematics and computer science, and in short, any question susceptible to quantitative formulation. As such, these skills lie at the core of STEM disciplines, and this proposal addresses a much needed programmatic focus that will prepare our students for today's industrial and academic careers by a combination of basic principles and practical training.</p>	
Approvals:	
Department Chair: <i>M. Hossein Partovi</i>	Date: <i>10/14/09</i>
College Dean: <i>Laurel Dufferen</i>	Date: <i>10/22/09</i>
University Committee: _____	Date: _____
Associate Vice President and Dean for Academic Affairs: _____	Date: _____

2. Purpose of the certificate program & certificate guidelines

There are two primary objectives for the proposed *Scientific Computing and Simulation* (SCS) certificate program:

- Responding to current trends in academic and industrial career paths in STEM disciplines which increasingly emphasize extra-curricular experiences, especially general computational skills of simulation and modeling.
- Reorganizing the elective courses offered by the Physics & Astronomy Department with a view to making them better focused and more relevant to students' future careers, as well as achieving better resource efficiency by targeting a wider group of students.

The proposed program clearly meets the guidelines for certificate programs as it has a well-defined objective different from existing degree programs (as stated above), requires a sequence of degree credit course work (see item 5 below), and provides a specific competence widely sought by academic and industrial sectors.

3. Need for the Program

The two primary objectives stated under item 2 arise from (i) the need to provide our students with the skills and competencies widely sought, and in some cases required, by almost all future career paths in STEM areas, and (ii) the urgent need to redesign our elective course offerings in order to make them more relevant and marketable, as well as more resource-efficient and sustainable under current and future budgetary conditions.

4. Impact on other Academic Programs

The two upper-division courses comprising the core of this program, PHYS 162 and 163 (see item 5 below), have no equivalent on campus, so there will be no negative impact on other units. Examples of computationally oriented courses are CHEM 245 (Computational Chemistry) or BIO 224 (Genomics, Proteomics, and Bioinformatics), and a number of programming courses in the Computer Science Department. An inspection of these courses shows that they are different in content, objectives, prerequisites, and level of covered material. Generally speaking the two courses constituting the core of this proposal, namely PHYS 162 and 163, stand to the above-mentioned offerings as the general science and mathematics courses stand to the specialized courses in science and engineering departments. In other words, while these courses may in certain respects be considered introductory or complementary with respect to the more specialized ones such as the graduate courses named above, they are nevertheless quite different in both level and focus. In case of the courses offered by the ECS college, the proposed courses are focused on an altogether different area of application of computers, namely *scientific* computing. On the other hand, the proposed certificate program is expected to have a positive impact on other courses and programs focused on computer applications by virtue of providing the students with the relevant background as well fostering their interest in the subject. A perusal of similar offerings at other institutions supports the necessity of basic scientific

computing courses as background and support for specialized science or engineering style courses.

5. Requirements

The *Scientific Computing & Simulation* certificate program requires the completion of 14 credit units detailed below with an overall GPA of no less than 2.50.

Required Course work

5a. Background courses 8 units

All majors other than Mathematics:

PHYS 5A and 5B, or two of PHYS 11A, B, C

(These are existing lower-division physics requirements for nearly all NSM and ECS disciplines.)

Mathematics majors:

105A and 105B

5b. Scientific computing courses 6 units

PHYS 162 *Scientific Computing: Basic Methods* (3 units)

PHYS 163 *Scientific Computing: Modeling, Simulation, and Visualization* (3 units)

These upper-division courses are revised versions of our *Computational Physics* and *Mathematica workshop*; see the attached "Course Change Proposal Form A" for the revised courses. A typical schedule for completing the course requirements is:

Year	Fall Semester	Spring Semester
AY 1	PHYS 11A or 5A	PHYS 11B or 11C or 5B
AY 2	PHYS 162	PHYS 163

6. Department & Faculty

The primary unit responsible for the proposed program is Physics & Astronomy, and the faculty involved in implementation are

- **Hossein Partovi** (Professor and Chair, Physics & Astronomy)
- **Jerome Bürki** (Assistant Professor, Physics & Astronomy)

Other faculty in the department may be involved in teaching the above courses. An effort will be made to engage interested faculty in the NSM and ECS Colleges to mentor, supervise, or advise on capstone student projects in PHYS 163.

7. Duration

This program is being proposed without a termination date at this time and is expected to endure, subject to frequent evaluation and assessment.

8. Number and Background of Participants

All students in STEM disciplines, primarily from the Colleges of NSM and ECS, are considered potential participants. The number of participants is expected to be in the 12-24 range during the first few semesters, and grow thereafter.

9. Resource Considerations

As stated above, this program may be considered part of a plan to reorganize the elective offerings of the Physics & astronomy Department. An objective of this reorganization is to achieve better resource-efficiency by increasing enrollment. In recent years, the Department has taught PHYS 162, *Computational Physics* (3 units), as well as a PHYS 199, *Mathematica Workshop* (1-2 units, repeatable). Thus, considering the fact that as this program is phased in some of the other elective courses (e.g., the "old" PHYS 162, PHYS 186) will be phased out, it is clear that the expected net effect of the program will be to increase the resource efficiency of the elective offerings in the Department without requiring additional teaching unit outlays overall. With respect to other resources such as equipment (primarily computers in this case), the existing computers in the Department (e.g., instructional laptop computers) as well as software available to the Department and University will meet the needs of the required courses in the foreseeable future. The Department set up a *Linux* cluster of 9 desktop machines (University recycle units) in S08. In addition, one of its new faculty members (J. Bürki) has recently acquired two relatively powerful workstations (each with two Intel Xeon CPU's) using his startup funds. Thus, there is ample computing hardware capacity for large-scale computation as well.