

CALIFORNIA STATE UNIVERSITY, EAST BAY

DESIGNATION CODE: 2011-12 CAPR 6

DATE SUBMITTED: February 2, 2012

TO: The Academic Senate

FROM: The Committee on Academic Planning and Review (CAPR)

SUBJECT: Five-Year Program Review for Physics BA and BS

PURPOSE: For Action by the Academic Senate

ACTION

REQUESTED: Acceptance of the Five-Year Program Review of the Physics BA and BS programs in the College of Science at California State University East Bay and the recommendation that they both continue without modification. The date of the next Five-Year review is 2016-2017.

BACKGROUND

At its meeting on November 3, 2011, CAPR invited members of the Department of Physics to orally present the outcome of their five-year review process completed in 2010-11 and submitted to CAPR for review in 2011-12 as prescribed in the Academic Program Review Procedures (08-09 CAPR 23 (revised)). Department of Physics Chair, Dr. Derek Kimball, had previously supplied the Senate Office with a full version of the program self-study, five-year plan, external reviewer's report and program response to the external reviewer's report. Prior to this meeting, the CAPR liaison to the Physics program review, Sam Tran, examined the five-year review document in detail. At this meeting, Dr. Kimball, who was accompanied by department members Dr. Jason Singley and Dr. Erik Helgren, presented a summary of the Physics five-year review to CAPR and participated in a question and answer session concerning the review.

Overview description of the program

The Physics department has both a BA and a BS degree program in Physics. BA majors may choose an option in Physics Education geared to those seeking to pursue a single-subject teaching credential. The majority of the courses offered serve the needs of other majors and general education (GE). According to fall enrollment data compiled by PEMSA, as of 2009 there were only 28 majors who were served by a tenure-track full-time equivalent faculty of 5.6, generating a full-time equivalent student (FTES) level of 205.3, an increase of 125% over the last five-year review period. The faculty allocation breakdown between the teaching of major courses, service courses to other programs, and GE courses is, according to departmental assessments for Fall 2009, roughly 21%, 35%, and 44% respectively. The proportion of FTES taught by lecturers was 57% and the average student-faculty ratio was 36.8 in Fall 2009. The BA degree requires 87 units for graduation and the BS degree requires 105 units plus additional GE courses. Thus, with GE requiring 72 units, some of which are satisfied by courses taken for the major, both the programs fall within the 180 units requirement of the CSU. The majority of students elect to complete the BS program.

Overview of the documents submitted to CAPR

A short summary of the five-year review provided by the Physics department for its BS and BA degrees precedes the self-study, five-year plan, external reviewer's report and response to the external reviewer's report. Note that the five-year documentation provided by the Department of Physics combines the BA and BS program information. This is typical of many departments' approaches to their five-year review since although through this process CAPR approves continuation or discontinuation of programs, not departments, many departments' programs significantly overlap in terms of faculty, resources, recruitment, climate, and the many other program areas required to be reported on as part of the five-year review process. As such, it has not proven possible for CAPR to distinguish between the two programs with respect to their specific health or separate the general department needs for the next five years from any program-specific needs.

Program's Self-Study (period 2006/07-2010/11)

Summary of specific areas of the Self-Study

The Physics program self-study follows well the outline and content required by the Academic Program Review Procedures and begins with a reflection on the previous five-year review indicating that it instituted most of the planned changes in the programs.

- Creation of a new BA degree.
- Revision of the old BS degree to include new classes, increasing the total unit requirement to 105.
- Switching several 4 unit, two quarter class sequences to 3 unit, three quarter sequences.
- Adding a course in Solid State Physics, a second quarter of Thermal and Statistical Physics, Linear Algebra, and Partial Differential Equations to the BS degree.
- Introducing an optional Undergraduate Research Course.
- Adding a required Physics Capstone course to both degrees.

The department successfully managed to increase its number of majors as planned, more than doubling them from an average of 10 ten years ago, to 28 at the end of this review period, exceeding the target goal. Two new hires were made replacing two retirees (one who was FERPing), with the new faculty stimulating research activity and contributing to securing a combined departmental research funding of close to \$2 million, particularly in the area of Atomic and Solid State Physics. Department faculty have been active in the Math and Science Teacher Initiative and East Bay Science Project.

With respect to curriculum, the self-study details the important role played by the Physics department in servicing other majors and the GE program, with other departments' students representing the majority of enrollment. The department has 11 classes and labs approved for GE credit in areas B1, B3 and B6. The self-study details the teaching methods used to ensure achievement of learning outcomes for large lecture and lab classes with high student-faculty ratios. Similarly, the teaching approaches taken in the major core classes are discussed and the use of the online homework system *Mastering Physics* is highlighted. The lower-division core also serves Chemistry and Engineering majors, the latter department's programs providing almost half the enrollment in 2009 and more than half in 2010.

The department's learning outcomes assessment plan is presented in Appendix C of the document and summarized in the self-study. In lower division classes, significant emphasis is placed on formative assessment through in-class and homework activities and examinations that are used to adapt instruction to the needs of students as they proceed through the material. Summative assessment takes the form of a standardized pre-course and post-course test of conceptual understanding. Appendix C details all of the

course descriptions and has a brief discussion of the learning outcomes for PHYS 1001, 1002, 1003 and 2004. The outcome of having a “general understanding of the fundamental principles of physics” is assessed with true/false questionnaires administered in PHYS 1001/2701 and PHYS 1002/2702. Data for the period 2007-10 is provided. This shows that the percentage of correct scores achieved by students for the 12 topic categories remained consistent over the period at between 44-51% in the pre-test and 69-75% in the post-test. It is commented that the goal is to achieve post-test scores of 90-100% but as yet, the department has not identified the steps needed to achieve this goal from the assessment studies. The outcome of being able to “effectively perform a physics experiment, analyze the acquired data, draw meaningful conclusions, and communicate these results to peers” is assessed with an evaluation rubric designed to grade oral communication of scientific ideas in laboratory classes. The outcome of having “in depth knowledge of the foundational subjects in physics” is assessed via the administration of the Physics GRE exam in the capstone course for majors. The average score is presented for three of the years from 2006-2010. No commentary is provided as to what score constitutes a satisfactory outcome for majors and the problems of using this data is discussed in the self-study. It is not currently considered a good learning outcome measure. The assessment plan does not currently capture data on problem-solving skills and laboratory skills. The self-study is somewhat limited, therefore, in terms of presenting concrete assessment results and a discussion of how these are being used to improve the program and the modifications required for the coming years. It does indicate that there is a need to make sure the GRE is taken when students have achieved senior status, and not junior status, as is presently the case for many majors. The self-study does not give a very detailed picture of how far the Physics programs have come in developing a program-level learning outcomes assessment for the department’s own majors or for CSUEB students demonstrating their GE science competency or acquiring fundamentals of physics for other majors through taking physics courses.

The self-study compares the CSU East Bay Physics BS degree to three other CSU’s – SFSU, Stanislaus and Chico, and to UC Berkeley, and finds them comparable. It is not clear why these particular programs were selected, except that they are all in Northern California, or how our East Bay programs compare to nationally recognized programs. One area of difference with the four programs selected is the lower number of units devoted at East Bay to the lower division General Physics and gateway upper division Modern Physics classes. It details the recent success in creating a Physics Education option within the BA degree and an online upper-division class sequence aimed at prospective middle school teachers. The Physics minor was revised in fall 2009 in an effort to attract students (none had elected to take this program in a decade), reducing it from 47 units to 28 units with more flexibility.

The self-study indicates that as of 2009 there were 28 majors who were served by a tenure-track full-time equivalent faculty of 5.6, generating a full-time equivalent student (FTES) level of 205.3, an increase of 125% over the last five-year review period. The proportion of FTES taught by lecturers was 57% in 2009. The average student-faculty ratio was 36.8 in fall 2009. This has risen from 16.8 in fall 2005, a factor that could significantly affect program quality if it continues, as pointed out in the self-study, particularly with respect to laboratory instruction. With a small number of majors, advising is straightforward and majors interact closely with faculty, particularly in research. In response to a question on graduation rates, it was communicated to CAPR by Chair Kimball that many majors choose to extend their time to graduation so as to continue to be able to do undergraduate research, amassing many more units than the 180 needed to graduate. This is substantiated by the fact that the average number of majors rose from 21 to 28 from fall 2005-2009 while the number of degrees awarded from 04-05 to 08-09 was 15, an average of only 3 per year. Student recruitment or retention does not seem to be a problem for the department. It was noted that some students declaring a Physics major do change to other majors because their high-school preparation in science is inadequate and cannot be satisfactorily remediated. With respect to faculty, the Physics program has had one successful hire between 2006-2011 (adding to the appointment of the current Chair in fall 2005). The two most recent hires (2005, 2008) have been retained, reversing the tendency to lose newly-hired faculty in the previous five-year review period.

The self-study discusses resource issues and details the use of instructional technology by majors and faculty initiatives such as participating in East Bay Replay, adopting the Mastering Physics online homework system, and the use of clickers in freshman cluster GE classes. The department has invested \$1,000 annually from its general fund to purchase materials for labs, much less than the estimated \$10,000 needed annually to maintain instructional quality. Instructional software is only partly supported by the university, with IT only purchasing Mathematica, leaving the department having to find funding for MultiSim and Labview. The cost of these site licenses was not provided.

The self-study does not discuss course offerings at the Concord Campus and is not clear what proportion of courses is offered online. No comments are provided on whether issues of multi-cultural learning are relevant and race and ethnicity data for majors is not provided. The self-study indicates that neither of the BA and BS degrees requires more than 180 total units (including GE) to graduate.

Summary of supporting data

The Physics program review documentation provides nine supporting appendices. They include the faculty CVs, news articles concerning the Physics program, the assessment tools and data, tenure-track position requests, a proposal for a new program in Engineering Physics, a list of equipment requests, an advanced lab proposal, a supporting memo from Dean Leung, and copies of annual reports submitted during the review period (06-07, 07-08, 08-09, 09-10).

External Reviewer's Comments & the Department's Response

In the five-year review process, programs prepare their self-study and their five-year plan (draft) and submit these to their external reviewer prior to their visit to campus. The program then gets the chance to finalize their five-year plan based on comments made by the external reviewer and the response of their Dean to their document and the external review report. It is thus summarized in this CAPR recommendation prior to its analysis of the final five-year strategic plan. The external review of the CSU East Bay Physics program was conducted by Dr. Lynn Cominsky, Chair of the Physics and Astronomy Department at Sonoma State University. She visited the campus on April 8, 2011 and met with the Dean of the College of Science, all of the members of the department, and a selection of students.

According to Dr. Cominsky, the Physics department is to be commended for providing engaging student-centered teaching and learning and for its success in increasing the number of majors despite financial constraints. The program is solid and has the potential for distinctive elements to achieve national recognition. The external review generated the following major strategic points as well as a number of additional recommendations for the coming five years:

- In light of the considerable level of year-round undergraduate-faculty research, and with a view to its expansion, faculty should receive workload credit of 1/3 WTU per student research project.
- Due to the rapid expansion of FTES, a new hire in experimental physics should be secured to maintain program quality.
- Due to the importance of adequate laboratory equipment, significant additions and upgrades must be made on an incremental basis over the coming five years.
- To better take advantage of research laboratory equipment, its use should be incorporated into instructional activities through redesigned experiments in lab classes.
- As FTES growth continues, additional technician resources should be secured to support laboratory and research activities.
- Office space is severely limited and no more than two faculty should be expected to share an

office; this should be addressed as funding becomes available for capital improvement.

- Plans to develop an Engineering Physics degree should be considered carefully, especially with respect to the resources required to support this new program given the limited number of faculty.
- The department should join the Physics Teachers Education Coalition (PTEC) to further promote its activities in preparing students to become high-school physics teachers.
- The department should develop a weekly colloquium (seminar) series for students in the form of a 1 unit course.
- The department should critically assess the curriculum to determine the opportunities for students to acquire key technical skills, and should revise the program learning objectives to modify and expand on the three currently articulated which are insufficiently detailed.

Note that the external reviewer's comment about the senior capstone course was a little confusing. She suggests that all students be involved in a distinctive culminating experience and that this be geared to students going into industry and teaching as well as those going into research. The newly developed capstone class she refers to is defined in the catalog as a "Comprehensive overview and synthesis of undergraduate physics" and is a 1 unit course. From the self-study, it seems that the purpose of this course at present is the administration of the GRE exam and it is thus the vehicle for assessing the third of the department's three learning outcomes. Thus it seems that the reviewer is actually suggesting a new capstone project class be developed for all students; she noted that those students bound for research have plenty of opportunity to demonstrate their proficiency and similar opportunities should be offered for students to develop and demonstrate technical skills in a range of key areas needed by physicists heading to industry and teaching.

Based on Dr. Cominsky's review, the Physics department made a number of amendments to its five-year plan. They are identified in the following section which summarizes the final five-year plan submitted by the Physics department. Note that the Chair already followed up on one recommendation; to join the PTEC.

Program's Five-Year Strategic Plan 2011-2016

The five-year plan for the Physics program follows closely the outline and content required by the Academic Program Review Procedures and begins with curriculum. It indicates that the department will modify its two majors and minor to require its students to taken PHYS 2004, addressing the lower number of general physics units compared to comparable programs as identified in the self-study. It will also require BA and BS majors to take a fourth quarter of calculus. As suggested by the external reviewer, the program will examine how it can best offer a capstone experience to all majors equivalent to the out-of-classroom research project that the majority of students currently complete with a faculty member. The current capstone class, PHYS 4950, does not currently fulfill this function. Also as suggested by the external reviewer, the department will explore the feasibility of holding weekly seminars that students would attend as part of a required 1 unit course, piloting this idea in an existing class with the object of creating a new required course if deemed beneficial. Also planned for the next five year period is the development of a new degree program in engineering physics aimed at training physicists who will pursue careers in industry, balancing out the current emphasis on training either for graduate research or for teaching. While it will involve collaboration with the Engineering department, the new major program will be wholly based in the Physics department. The program will consider adding an additional course, PHYS 3011, to its stable of GE-approved classes and continue its involvement in the lower division GE cluster program.

With respect to students, the coming five-years is expected to yield a wholesale review of program learning objectives and the mapping of desired skills to the current curriculum. It is expected that this will

result in a revised assessment plan and measures to assess outcome achievement. The goal for the next five years is to increase the number of Physics majors at East Bay to above 40 from the current level of 28. An assessment is provided of the ratio of Physics majors per 1,000 enrolled students across the CSU and East Bay is currently more or less at the median. Increasing the number of Physics majors to above 40 would allow for more frequent offering of senior required classes and allow for greater flexibility, avoiding the need to mix junior and senior standing students in the same section, as well as the development and offering of electives. Development of an applied Engineering Physics major will be instrumental in this goal, as will continued efforts to secure research grants and the planned development of a recruitment program by faculty using resources developed by the American Physical Society.

A particular strategic planning concern for the next five years is how to maintain instructional quality given the significant increase in FTES of 125% over the last five years with a reduced number of full-time tenure-track resources. The majority of sections are now taught by part-time faculty, the introductory physics sequence for life-sciences majors (PHYS 2701, 2702, 2703) now enrolls 250 students in two sections, the general physics sequence taken by physical science majors (PHYS 1001, 1002, 1003, 2004) is already at the desired capacity, and upper division core courses are offered only every other year. Consequently, the department is seeking to reduce the average section sizes in the introductory physics sequence to 60, add sections of the general physics sequence, and add sections of upper division courses so that they can be offered annually. Since this will increase the teaching load, these stated goals cannot be achieved without additional full-time faculty. Thus the goal for the coming five years is to add two tenure-track faculty. A proposal has been submitted for a new hire in 2012-13 in the area of atomic physics and a second request is expected in 2014-15 or 2015-16. The specialty of this second position was not listed although the external reviewer recommended someone be hired in the area of experimental physics. Even with new hires, worries were expressed in the five-year plan, however, concerning the continuing ability of the Physics faculty to keep up with teaching, research, and laboratory management demands and that a “critical part of our physics curriculum is in a state of deterioration”. The plan indicates that the solution to this issue will require initiatives at the university level, for example, the Provost’s office authorizing reduced teaching loads for faculty engaged in professional activity.

With respect to other resources, it is of urgent concern to the department that it develop a secure funding model to maintain the quality of laboratory course instruction. A number of funding requests and initiatives were made in 2010-11, including requests for one-time equipment funding from the Provost, which CAPR understands, were granted to a significant degree. New, upgraded and replacement equipment will be needed on an ongoing basis and, as indicated in the response to the external reviewer, it is hoped that funding will be forthcoming from the newly instituted A2E2 fees at East Bay. Lastly, with reference to other suggestions made by the external reviewer not covered in the above discussion, in the next five years the Physics department also plans to petition the College of Science to compensate Physics faculty for out-of-classroom research work with students, and to seek additional technician resources for the College of Science so that the full-time Physics technician can devote more of his time to the Physics programs; currently he also functions as technical support to the Engineering programs as well as offering support to another program that lost its technician.

CAPR Analysis of the Program’s Five-Year Review

It is clear from the rising enrollment numbers that the Physics program is serving a growing demand across multiple programs for Physics instruction; the number of majors has been rising even though the faculty resources devoted to their instruction have not risen and SFR levels have increased. Based on the very thorough self-study, five-year plan, and response to the external review, the following points are offered by CAPR with respect to strategic planning that can be the basis for future annual reporting until the next five-year review. Hopefully these will be helpful in the drafting of a memorandum of

understanding with the Provost's office for the coming five years in terms of resource needs/allocations and objectives for the program.

a. Program

Based on the strategic plan provided to CAPR by the Physics department, the following program-related recommendations are offered:

- The department should follow through with the proposed changes to its BA, BS and Minor required courses; CAPR will look for the appropriate program modification requests in the coming five years.
- The department should examine how best to offer a capstone experience to all majors be they oriented to careers in research, teaching or industry; CAPR will look for a discussion of findings in a future annual report.
- The department should pilot a series of weekly Physics seminars with a view to establishing a new course that gives 1 unit of credit to students to attend; the department will report back on the success of this pilot in the corresponding year's annual report.
- The department should pursue the development of a new degree program in Engineering Physics aimed at training applied physicists who will pursue careers in industry; CAPR will look for the appropriate program approval requests in the coming five years.
- The department should engage in a wholesale review of program learning objectives and the mapping of desired skills to the current curriculum. It should revise its assessment plan and measures used to assess outcome achievement, reporting on these changes in its annual reports to CAPR.

b. Resources

The main concern for the coming five-years is to address the need for additional tenure-track faculty to service the growing enrollment both of a small but growing number of Physics majors, a large body of other science majors, and a significant population of the East Bay student body pursuing GE credits in Area B. Another core concern is the maintenance of laboratory instructional quality through continued investment in adequate equipment and materials. CAPR therefore proposes the following recommendations for the coming five-years:

- The department should seek a minimum of two tenure-track positions to meet the growing demand for Physics instruction and permit it to maintain and improve the quality of the programs offered.
- Over the next five years the Physics department should increase the number of sections offered in the introductory physics sequence to achieve the stated goal of an average class size of no more than 60, add one or more sections of courses in the general physics sequence each quarter so as to keep class sizes at or below the desired level to maintain instructional quality, and offer all upper division courses annually instead of bi-annually.
- The department should secure external funding for additional research-related equipment (that should, once secured, be more fully leveraged for enhanced classroom and laboratory instruction and student research as suggested by the external reviewer) and petition the Provost's office for secure support for laboratory materials and equipment used in instruction from the A2E2 funds paid by students.
- The department should petition, along with other departments in the College of Science, for a restoration of technician support across the college; the Physics Chair should work with the other

Science Chairs to assess those support needs and how much of them are a) currently being met by the Physics technician, b) currently being performed without compensation by faculty or students, or c) currently going unmet for a lack of resources.

Each of the recommendations above should be reported on in one or more annual reports over the coming five years until the next review. It is expected that the next self-study will explicitly review whether these recommendations were or were not achieved and why, along with any additional initiatives that might be developed that were not envisaged as part of this strategic planning process.

This document and the recommendation to approve the Physics BA and BS programs for continuation without modification was approved unanimously by CAPR at its January 19, 2012 meeting.

CAPR Recommendation for Continuation of the Program

Acceptance of the Five-Year Program Review of the Physics BA and BS programs in the College of Science at California State University East Bay and the recommendation that they both continue without modification. The date of the next Five-Year review is 2016-2017.