California State University, East Bay

5-Year Program Review for
B.A. and B.S. in Physics

2010-2011

Self Study and 5-Year Plan approved by faculty on: March 7, 2011

External Reviewer Report received by the program on: April 18, 2011

Program’s Response to External Reviewer’s Report completed on: April 26, 2011

Complete 5-Year Program Review Report submitted to CAPR on: April 29, 2011
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1. **Summary of the Programs**

   The Department of Physics offers both a Bachelor’s of Science and a Bachelors of Arts degree. Students pursuing the B.A. degree may also choose an option in Physics Education. The programs have a relatively small number of majors, which allows for a high level of student faculty interaction. In particular, many of our undergraduate participate in faculty led research projects. The majority of the department’s course offerings is in general education and service courses for other departments. Hence a large amount of the department human and physical resources are expended in these areas.

   Faculty in the Department of Physics are active in teaching, University service, and professional activities. Appendix B offers a sampling of some news items highlighting the work done by our faculty and students. Over the past five years the faculty in the department have brought in almost two million dollars in extramural funding. Physics faculty are active in several STEM education initiatives on campus as well as research in atomic physics, material science, and solid state physics.

   Since the last five year review the department has instituted most of the planned changes to our program. In particular we created a new BA degree and strengthened our BS degree. More recently we have added an option in our BA degree for students interested in teaching physics in secondary school. The number of majors in our program has slowly increased since the last review, and in particular rebounded from the very low number the department experienced in the late 90’s. One full time tenure track faculty and one 0.5 FERP faculty have left the department and been replaced by two new tenure track faculty, resulting in a significant change for the department.

   With the new faculty there has been a substantive change in the teaching style in the physics program. Most faculty are now using the outcomes of physics education research to guide their teaching practices. Briefly, this involves a more student centered approach where students are actively engaged in their learning during lecture. These research based teaching practices are now being used by most of the faculty in general education courses, services courses, and major courses. The department has also become more systematic in its assessment practices. Since the last review the department has developed a new assessment plan for the major, and uses multiple forms of formative and summative assessment in classes.

   The department has seen tremendous growth in its teaching load over the past five years, which is up by 125%. This growth is mainly due to the increased enrollment in our service courses for science and engineering majors and increases in some of our general education courses. In general education the department has created several new courses to meet the upper division B6 requirement in science. The department also continues to be active in the first year learning community general education program.

   One of the greatest challenges facing our department is the lack of resources for keeping up the department’s infrastructure. The physics programs are extremely equipment intensive. For the past decade there has been little to no funding mechanism for replacing equipment. Additionally, the department general budget has been cut sharply over the past five years hindering our ability to repair and replace broken equipment. At the same time our enrollments have surged, placing a larger burden on our antiquated equipment. The department is in the position now of barely being able to offer an acceptable curriculum and has no ability to grow its enrollment in its service courses.
2. Self-Study

2.1. Summary of Previous Review and 5-Year Plan

The department has in large part carried out the last 5-year plan. Below we list the main points of the plan and the work that has been done in each area.

Curriculum - The department proposed to make significant changes to its program including:

- Replacement of the previous 88 unit BS degree with a new BA degree.
- Revision of the old BS degree to include new classes such that the total unit requirement is 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.

All of the proposed changes have been carried out. Most students are pursuing our revised BS degree with 105 units. Clearly the higher course load has not scared students off. We regularly have students taking Undergraduate Research, and the Physics Capstone course has given us a new mechanism through which to assess our students. Overall, students and faculty seem to be happy with the revised BS degree. The only prominent concern is that the workload of the new 3 unit classes is comparable to a 4 unit class for both students and faculty.

Students - At the time of the last report the number of majors had shrunk to about 10 from over 20 that the program sustained in the 1980’s. The prediction in the last report was that we would be able to increase the number of majors in the program, largely based on the changes described above.

The number of students has increased to 28 in the fall of 2009. The cause of this increase is not entirely clear, although we feel that the changes to our program described above gives the department a more attractive program. Another change has been the hiring of new faculty that will be described below. The new faculty tend to be more engaged with our students and provide opportunities for students to participate in research projects that students find appealing. The department has also made a concerted effort to engage students outside of the classroom at both formal and informal department gatherings. While the increases we are seeing are a positive sign, the goal of the department is to have 40-50 majors within 5 years. The steps we will be taking to increase our student population will be discussed later in the report.

Faculty - At the time of the last report, the department had three TT faculty with a search for a fourth in progress. The plan was to have a successful search, then hire another faculty in a few years. Emphasis was given to the need for more money for salaries and start-up packages, as well as research space to attract new faculty.

The department did in fact have a successful search, and hired Dr. Kimball who is an Atomic Physicist and started in 2005. In 2008 the department hired Dr. Helgren, a Solid State Physicist again following the plan set out in the last report. While start-up packages increased by over 100% for Dr. Kimball from the previous hire, and by 50% for Dr. Helgren from Dr.
Kimball’s package, salaries remain depressed compared to what Ph.D.’s in physics earn and space is still a problem in the department. At the same time that the department gained these new faculty members it lost Dr. Good and Dr. Preston who finished his 50% time FERP. The number of faculty now stands at four full-time tenure/tenure track and five part-time lectures.

Faculty in the physics department have been very active professionally, garnering almost $2 million in external funding over the past five years (Table 2.1.1). Areas where the faculty have been most active include atomic physics research, science education program development, and solid state physics and material science research. Key activities in each of these areas are described below. Complete faculty CV’s can be found in Appendix A while several news articles from the campus’s alumni magazine covering accomplishments can be found in Appendix B.

Science Education

Dr. Singley has been a Co-Director of the campus’s Math and Science Teacher Initiative since the program’s inception in 2006. In this role he has created a variety of programs to encourage and help math and science students pursue careers in teaching. An offshoot of this work was a two year Transfer Project for Future Math and Science Teachers that involved nine community colleges and two CSU’s. The aim of this project was to create an advising network and common transfer pattern for community college students interested in transferring to the CSU and going on to become math or science teachers. Both Dr. Singley and Dr. Johnson have participated in the Science Teacher and Researcher (STAR) program as faculty liaisons, overseeing interns at regional national laboratories during the summers. Dr. Johnson is currently creating two new physics courses that will be part of the Universities Foundational Level General Science Certificate. The classes will be offered in the winter quarter for the first time. Dr. Singley is also a member of the East Bay Science Project - a group of science faculty who run professional development science programs for practicing K-12 teachers. Recent and current projects include a 2 year NASA funded project for high school teachers and a new five year NSF funded project for middle school teachers.

Atomic Physics

Over the past five years a state-of-the-art, nationally recognized atomic, molecular, and optical physics research program has been developed with significant funding from the National Science Foundation as well as internal grants. The focus of the program is development of techniques and systems for precision tests of fundamental physics and application of these techniques and systems to tests of fundamental symmetries of nature and searches for anomalous, heretofore undiscovered interactions. We have produced 15 publications in peer-reviewed journals, and twenty-five undergraduate students have worked in the atomic physics laboratory over the past five years, and many have been co-authors on the publications and have presented talks at regional and national meetings.

This research has been funded by two consecutive National Science Foundation grants with a budget totaling nearly $600k. Articles outlining the idea for the experiment and reporting new achievements in the sensitivity of the dual-isotope magnetometer have been published in the Journal of Applied Physics and Bulletin of the American Physical Society, and talks have been presented at the meeting of the Division of Atomic, Molecular, and Optical Physics (DAMOP) of the American Physical Society (APS), the premier atomic physics conference in the U.S., and at
the International Conference on Atomic Physics (ICAP), the premier international atomic physics conference. Numerous students have presented talks at California APS meetings, Optical Society of America (OSA) meetings, at CSU – East Bay physics seminars, and at the national APS DAMOP meeting.

We have also recently been awarded a Major Research Instrumentation grant from the NSF that funded the acquisition of a femtosecond optical frequency comb and THz spectrometer for atomic, molecular, and condensed matter spectroscopy. The optical frequency comb system will be used in multi-photon direct spectroscopy of alkali and rare-earth atoms to search for predicted but heretofore undiscovered energy levels and measure the properties of these new energy levels, such as hyperfine structure and gyromagnetic ratios. This experimental program will vastly improve our knowledge of the complex spectra of rare-earth atoms and allow evaluation of potential candidates among energy levels in rare-earth atoms for new tests of fundamental physics. The THz TDS setup will be used to probe low energy excitations of correlated electronic systems and study quantum phase transitions, as well as characterize novel thin film photovoltaic systems and atmospherically relevant greenhouse gases and molecules.

Another major accomplishment of the atomic physics program has been the completion and publication of the second edition of Atomic Physics: an exploration through problems and solutions (Oxford University Press, 2008), a book written by CSUEB physics Associate Professor Derek Kimball with Dmitry Budker of UC Berkeley and David DeMille of Yale University. A new book, Optical Magnetometry, edited by Derek Kimball with Dmitry Budker from UC Berkeley and Michael Romalis from Princeton, is currently under preparation and is to be published by Cambridge University Press in 2011-12.

Solid State Physics

Dr. Helgren has established research programs in 1) renewable energy materials science and 2) metamaterial design modeling and measurement. Undergraduate led research in renewable energy materials science involves studying the effect of orienting carbon nanotubes in commercially available organic polymer used for solar cells in an attempt to improve the efficiency of these photovoltaic composite materials. An article highlighting this research was printed in the Winter 2010 quarterly East Bay magazine, a special edition dedicated to “sustainability” issues (see appendix B). Metamaterials are engineered structures that display non-intuitive optical properties, such as a negative index of refraction. Students have access to industry standard High Frequency Software Simulation (HFSS) tools in the research lab and have been modeling these engineered structures, specifically fractal patterns of these metamaterials to improve the bandwidth of the metamaterial response. The students leading these projects have presented their research at numerous conferences over the past two years; including the California division APS meeting and at the 2010 McNairs scholar undergraduate research conference at UC Berkeley.
<table>
<thead>
<tr>
<th>Grant</th>
<th>PI/Co-PI</th>
<th>Year</th>
<th>Agency</th>
<th>Amount</th>
</tr>
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<tbody>
<tr>
<td>Search for Anomalous Proton Spin Interactions with a Dual-Isotope Rubidium Magnetometer</td>
<td>Kimball</td>
<td>2010-2013</td>
<td>National Science Foundation</td>
<td>$309,514</td>
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<tr>
<td>Math and Science Teacher Initiative</td>
<td>Singley</td>
<td>2010-2011</td>
<td>CSU Chancellors Office</td>
<td>$135,000</td>
</tr>
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<td>Acquisition of a Femtosecond Optical Frequency Comb and THz Spectrometer for Atomic, Molecular and Condensed Matter Spectroscopy</td>
<td>Kimball, Helgren, Singley</td>
<td>2010-2011</td>
<td>National Science Foundation</td>
<td>$393,388</td>
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<tr>
<td>Math and Science Teacher Initiative</td>
<td>Singley</td>
<td>2009-2010</td>
<td>CSU Chancellors Office</td>
<td>$125,000</td>
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<tr>
<td>A Model Community College Transfer Program for Future Mathematics and Science Teachers</td>
<td>Singley</td>
<td>2008-2010</td>
<td>S.D. Bechtel Jr. Foundation</td>
<td>$280,000</td>
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<tr>
<td>Math and Science Teacher Initiative</td>
<td>Singley</td>
<td>2008-2009</td>
<td>CSU Chancellors Office</td>
<td>$150,000</td>
</tr>
<tr>
<td>Search for a spin-gravity coupling using laser-addressed atomic gyroscopes</td>
<td>Kimball</td>
<td>2007-2010</td>
<td>National Science Foundation</td>
<td>$254,150</td>
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<tr>
<td>Math and Science Teacher Initiative</td>
<td>Singley</td>
<td>2007-2008</td>
<td>CSU Chancellors Office</td>
<td>$150,000</td>
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<tr>
<td>Math and Science Teacher Initiative</td>
<td>Singley</td>
<td>2006-2007</td>
<td>CSU Chancellors Office</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>$1,847,052</td>
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</table>

Table 2.1.1. External funding generated by physics faculty over the past five years.

2.2. Curriculum and Student Learning

The department offers a variety of different courses that serve several different groups of students. Physics majors take courses in the department in both lower and upper division. Several other majors, most of them in the sciences, require lower division physics courses as part of their majors. Therefore a substantial part of the physics course offerings is in these service courses for
other department. The department also serves students across the University with its General Education courses in both lower and upper division. Table 2.2.1 shows the breakdown of the number of lecture and laboratory courses in each of these areas as well as SCU, WTU, and SFR for the Fall of 2009.

<table>
<thead>
<tr>
<th></th>
<th>Lecture</th>
<th>Laboratory</th>
<th>SCU</th>
<th>WTU</th>
<th>SFR</th>
</tr>
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<tbody>
<tr>
<td>Major courses</td>
<td>4</td>
<td>3</td>
<td>415</td>
<td>17</td>
<td>19.5</td>
</tr>
<tr>
<td>Service courses</td>
<td>2</td>
<td>11</td>
<td>987</td>
<td>28</td>
<td>28.2</td>
</tr>
<tr>
<td>GE courses</td>
<td>8</td>
<td>3</td>
<td>1712</td>
<td>36</td>
<td>38.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>14</td>
<td>17</td>
<td>3114</td>
<td>81</td>
<td>32.5</td>
</tr>
</tbody>
</table>

Table 2.2.1 Department of Physics course offering summary for Fall 2009

Two caveats should be noted when discussing the above table. The department has three GE courses that are part of the freshman learning communities that are only offered in the Fall. Therefore while GE is always an important part of our class offerings, its size is somewhat exaggerated in the above table. Secondly, the lower division course for physics majors also serves as a service course for chemistry and engineering majors. This course is included in the major course section above.

More than most departments, the courses we teach outside of our major represent the majority of our teaching load and require the majority of our resources. In the discussion below each of the three classes of courses will be discussed separately.

**Service courses**

The department offers a three quarter Introductory Physics sequence (2701, 2702, 2703) that is required for biology, chemistry, earth science, and kinesiology majors. The course has both a lecture and laboratory component and typically enrolls 250 students per quarter. A few of the BA options in some of these majors as well as liberal studies majors are instead required to take 1700 and 1780, a class that primarily serves GE and will be discussed in that section.

The learning outcomes for this course are:

- students will learn to reason qualitatively and logically about physics phenomena
- students will be able to express their knowledge in multiple forms (mathematical, graphical, pictorial, and verbal)
- students will learn to solve quantitative physics problems
- students will develop an understanding of the conceptual structure of physics
- students will develop an understanding of science as a process

Over the past several years enrollment in this course has grown substantially. The lecture courses typically have 100-150 students each, and the lab enrollment has grown to 24. At the same time there has been a definite shift in the faculty’s pedagogical philosophy and practices to a more student centered mode of instruction. The large size of the lecture courses has limited the ability to make dramatic changes to how instruction takes place. A large part of each lecture is
still spent with the instructor at the board dispensing information to a passive audience. However, the faculty does make an effort to involve the students as best as they can. A relatively innocuous change that has been instituted is to make use of some variation of “Think/Pair/Share.” In this exercise the instructor poses a question to the class and asks them to take a moment to think through their response. The instructor may then ask for a show of hands to vote on different answers. Without revealing the correct answer the instructor will then ask the students to pair up and discuss their responses. The students may be asked to vote again and share out with the class their reasoning. Another teaching technique regularly used in this class is a form of peer instruction. About 10 minutes per class is set aside to allow students to work together to solve a particular physics problem. The instructor observes the students and occasionally offers tips while the students are collaborating. At the end of the time the instructor leads the class in working out the correct solution to the problem.

The department uses a variety of techniques to do both formative and summative assessment of student learning in these classes. Formative assessments are carried out by monitoring student progress on online homework and in real-time by observing students working on class activities. For several years the department has been using Mastering Physics, an online homework management system. With this system the instructor has access to a wealth of data, generated automatically and in real-time. Instructors can see what homework problems students had the most problems with and discuss the key principles in class. Instructors can also see the individual answers that students attempted. The system also offers advantages for students as they get instant feedback on their work. In-class activities also act as a useful tool for formative assessment. The instructors can observe student discussions, identify common problems or misconceptions, and address them in class.

The department uses traditional midterms and final exams for a summative assessment, as well as a standardized pre- and post-test. Instructors share exams and student performance and informally discuss common problems and ways to address them each quarter. The department has developed a pre- and post-test to more formally measure student learning and provide year-to-year comparisons. The pre-test is given on the first day of class, and the post test is given either on the last day of class, or as part of the final. The tests are located in Appendix C along with recent results.

**GE courses**

**GE Physics Course Offerings**
- 1200 Behind the Music
- 1500 How Things Work
- 1700 Elementary Physics
- 1780 Elementary Physics Lab
- 1800 Astronomy
- 1880 Astronomy Lab
- 2005 The Science of Energy
- 3700 The Big Bang and Other Cosmologies
- 3710 Solar System Astronomy
- 3720 Stars and Galaxies
- 3750 Biophysics Tools in the History of Medical Research
The physics department offers a wide variety of lower division lectures and labs and upper division lecture General Education (GE) courses that satisfy the B1, B3, and B6 requirements respectively. These courses attempt to explain the structure of matter from the most elementary particles to complex materials used in a wide range of real world applications. The physical properties of Earth and its motion, its atmosphere and magnetic field are discussed. Conservation of energy and matter and how radiation and particles interact are covered sporadically in depth. Students demonstrate a technical understanding by using the internet in addition to materials provided in these courses. In labs, students learn how to use simple instruments such as rulers, meter sticks, timers and the computer to acquire data, analyze the data and communicate the understanding gained.

Students learn how to analyze scientific claims and apply their knowledge to real world situations. Use of mathematical equations in a general way allows students to better understand some of the high level physics concepts that explain the world around us. Students learn how to interpret data and this relates to overall concepts in physics.

Lower division lecture courses provide students with big ideas and detailed content in order to encourage students to perform scientific inquiry into a wide range of topics in physics. Non-science majors are exposed to physics concepts in an attempt to gain more experience in science using authentic inquiry. By sampling prior knowledge, students are asked to find out how do we know about fundamental physics and current events that relate to recent developments. By performing various homework assignments and exams, students begin to generate additional ideas and communicate them to other students and the professor. Several of our lower division lecture courses are part of the cluster program that involves team teaching a specific subject through three science departments over a three quarter year using the same day and time schedule for retention and cohort learning.

Lower division lab courses are separate from lecture courses and provide students with experience in experimentation with instrumentation, data acquisition and extraction of physics concepts by writing lab reports summarizing their work. Currently we offer lab courses in elementary physics and astronomy. Students are able to get one-on-one assistance from the professor in the lab courses.

Upper division lecture courses allow students to do further inquiry into specific fields such as Cosmology, Solar System Astronomy, Stars and Galaxies and Biophysics. Typically, upper division courses for non-science majors are distinguished from lower division by teaching at an elementary level, but use written research papers and class presentations to incorporate other communication skills into the science. Students demonstrate technical understanding by searching for good references and summarizing data and recent discoveries by various writing assignments in order to compare and contrast high technology instruments and how they affect human lives and how we perceive the world around us. Students are required to learn proper techniques for writing a paper on a specific topic in recent physics research and the citation of references.

We use a variety of assessment techniques in teaching non-science majors in our general education courses. Typically, assessment includes weekly homework and exams to probe what learning outcomes have been achieved by students. Pre-lecture quizzes given at the beginning of each class lecture has been successful encouraging students to pre-read the book. The pre-lecture quizzes are limited to figures and captions associated with the lecture to be given. Another way of encouraging students to search the internet for recent discoveries from the
National Laboratories uses a daily one page typed summary of recent research on a specific topic. More formal research summary papers are also offered as extra credit.

In the last five years, we have added several lecture courses to our GE offerings. Physics 1200, Behind the Music, is a course that starts off with the nature of sound waves and builds up to how different musical instruments produce a wide range of sounds. Physics 3710, Solar System Astronomy, and Physics 3720, Stars and Galaxies have been formulated and will be offered for the second and first times respectively this year. Physics 3750, Biophysics Tools in the History of Medical Research, has been offered online and has become very popular. Several of these course offerings are unique to our campus.

In the near future, we hope to offer one or more of our lower division courses online. We also hope to retain our Concord campus course offerings which have been limited to the Cosmology class.

**Major Courses**

**Lower Division**

The centerpiece of the lower division curriculum for the Physics major is the General Physics series (Physics 1001, 1002, and 1003), a three-quarter course which also serves other physical-science-oriented majors such as Chemistry and Engineering. In addition to the 4-unit lecture, there is a 1-unit laboratory section for each of the quarters. We have recently added a new fourth quarter of General Physics, Physics 2004, a 4-unit lecture with a 1-unit laboratory section. Physics 2004 will be offered for the first time in Fall 2011. As discussed in the Five-Year Plan, one of the first essential future steps is to incorporate Physics 2004 into the requirements for the Physics B.S. and B.A. degrees, as well as for the Physics Minor. Physics 1001, 1002, 1003, and 2004 cover all the major fields of physics: Newtonian mechanics, thermodynamics, waves and optics, electricity and magnetism, relativity, and quantum mechanics. The courses emphasize both conceptual understanding of physical principles and the ability to analyze and solve physics problems, balancing the development of physical intuition and scientific and mathematical techniques. In particular, the role of physics in elucidating fundamental relationships between disparate phenomena is repeatedly discussed: the relatively few basic principles of physics enable incredibly accurate quantitative understanding of diverse and complicated phenomena.

In the past five years a variety of pedagogical approaches have been used in General Physics:

- There is an increasing emphasis on active peer-to-peer learning in the lecture through discussion activities (where students work together to solve physics problems) and multiple-choice conceptual questions (with time given for discussion amongst students).

- As is the tradition in General Physics courses, a variety of demonstrations are performed in class, and the students themselves get hands-on experience investigating physics each week in the laboratory sections.

- We have adopted the online homework system *Mastering Physics* which provides tutorial-style problems, hints, and instant feedback to students.
• Lectures, in addition to incorporating some active, peer-to-peer learning strategies, use a multi-media approach with both work on the chalkboard and powerpoint slides to present material clearly and efficiently.
• Exams test both conceptual understanding and problem-solving skills.
• Brief (10 minute) “Science in the News” presentations are given each week in which topics at the cutting edge of physics are discussed, with the goal of generating interest and enthusiasm about the subject.
• Extra-credit “Challenge Problems” are used to stimulate interest and discussion among high-performing students.

There has been significant growth in enrollment in General Physics over recent years, as illustrated in the Chart 2.2.1 below. This growth has been coupled with an increase in Physics majors continuing on into upper division courses, indicating that, to some extent, retention efforts are succeeding.

![Chart 2.2.1 Growth of the enrollment in the General Physics sequence and enrollment of Engineering majors in these courses.](image)

The growth in the enrollment in Physics 1001 (and indeed, the Physics 1001-1003 series), is due in large part to the growth of the engineering major on campus, as seen in the plot above and the Table 2.2.2 below. Since physics is a foundational subject for the study of engineering, we anticipate both continued growth in enrollment in Physics 1001, 1002, 1003, and 2004, as well as a number of synergistic activities between the physics and engineering departments. This is certainly an area we believe that we can improve upon; as discussed in our Five-year Plan we will develop an Engineering Physics major to better serve those physics majors seeking employment in industry and engineering majors seeking a more technical or versatile degree.
### Table 2.2.2 Enrollment broken down by major for the introductory physics sequence.

<table>
<thead>
<tr>
<th>Major</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physics</td>
<td>1</td>
<td>5</td>
<td>9</td>
<td>7</td>
</tr>
<tr>
<td>Engineering</td>
<td>15</td>
<td>13</td>
<td>28</td>
<td>40</td>
</tr>
<tr>
<td>Chemistry/Biochemistry</td>
<td>5</td>
<td>5</td>
<td>15</td>
<td>9</td>
</tr>
<tr>
<td>Biology</td>
<td>3</td>
<td>4</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Geology</td>
<td>0</td>
<td>3</td>
<td>1</td>
<td>0</td>
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<tr>
<td>Math</td>
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<tr>
<td>Business</td>
<td>4</td>
<td>5</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>Computer Science</td>
<td>4</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Other</td>
<td>12</td>
<td>3</td>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td>48</td>
<td>40</td>
<td>72</td>
<td>69</td>
</tr>
</tbody>
</table>

**Assessment in Lower Division**

In the General Physics sequence, significant emphasis is placed on formative assessment during the class and in homework activities. In each lecture the presentation of new concepts is followed by short conceptual questions and peer-to-peer discussion that evaluate if students have understood the concept. If difficulties are identified, further discussion takes place immediately to address misconceptions. At least once a week and sometimes more frequently, in-class discussion problems are given where students work together to solve more complex physics problems for 10-15 minutes and the instructor goes throughout the class answering questions and assisting students. After the discussion problems are collected, the solution is presented by the instructor so students receive immediate feedback concerning how to approach solving physics problems.

The textbook we use for the General Physics sequence, Knight’s *Physics for Scientists and Engineers*, was developed based on physics education research, and we have recently employed the accompanying online homework system *Mastering Physics*. This has the significant advantage for students that feedback on their problem solutions is provided instantly and hints can be used to guide their study in a tutorial fashion. The instructor can access the statistics on student performance on problems to identify particular areas of difficulty for students. Instructors also host well-attended “study sessions” where students work together and with the instructor to solve the homework problems, offering another opportunity for formative assessment.

In laboratory sections, students and instructors interact closely to set up experiments, acquire and analyze data, observe and demonstrate important physical principles, providing yet another excellent opportunity for formative assessment.

Several exams (2-3) are given each quarter, and reviews of material are presented before the exams and a review of areas where students struggle are given after each exam. As best as is possible given the breadth of material to be covered and the number of students in the course, the curriculum in laboratories, lectures, and in homework is student-centered through a variety of formative assessment tools that enable instructors to address and adapt to particular challenges that students encounter as they proceed through the material. We believe that the formative
assessment tools could be made even more effective if lecture class size was reduced by offering two sections of General Physics instead of one, especially if as anticipated enrollment continues to increase.

For the purpose of **summative assessment**, we have also adopted a standard pre-course and post-course test for conceptual understanding (Appendix C) to assess student learning outcomes along with surveys of students to identify strong and weak areas of student preparation and of the course. The results of the conceptual survey from 2007-2010 for Physics 1001 are presented in the appendix, with areas of significant initial student misconception identified in the pre-test highlighted.

**Upper Division**

The upper division curriculum for the Physics major is rigorous and comprehensive, having since the last review been expanded to cover more subjects at greater depth in the B.S. program. A strength of the curriculum is the extensive hands-on laboratory experience. There are four upper division laboratory courses: Physics 3180 – Computational Physics, Physics 3280 – Electronics, Physics 3281 – Experimental Physics, and Physics 3283 – Advanced Laboratory, preparing students with a variety of technical skills necessary for both research and industry. The number of required units in the major devoted to laboratory courses is the most of the surveyed physics programs, which include three CSU programs as well as UC Berkeley. The total number of units required for the B.S. degree is similar to the surveyed institutions, and all of the core subjects in physics (classical mechanics, thermodynamics, electromagnetism, and quantum mechanics) are taught at an advanced, rigorous level (see table 2.2.3 below).

Enrollment in upper division courses has been increasing over recent years, reflecting a revitalization of the Physics major at CSU – East Bay. A regular two-year schedule where upper division courses are taught every other year with sustainable enrollment has been established. A sample of enrollment in a few key courses is shown in Chart 2.2.2 below.

![Chart 2.2.2 Enrollment in core upper division physics courses over the past 5 years.](attachment:chart.png)
Improvement in the enrollment in upper division physics courses has coincided with the strengthening of the upper-division curriculum for the B.S. degree and the establishment of a strong on-campus undergraduate research program. There are solid reasons for optimism that the number of physics majors and enrollment in upper division courses will continue to increase: the reputation of the department is growing, outreach to community colleges and high schools is improving, targeted programs for educating physics teachers are established and expanding, and we are planning to establish an Engineering Physics major on campus.

Several recent graduates obtaining the B.S. degree in Physics have succeeded in their goals of employment in physics-related careers and acceptance to graduate school (both Master’s Degree and Ph.D. programs), further proof of the improvement of the department and curriculum over the past five years.

A highlight of the Physics curriculum is the involvement of numerous students in our NSF-funded undergraduate research program, with emphasis on atomic, molecular, and optical physics, precision tests of fundamental physics, condensed matter physics, and materials science research. Our Department is building a regional and national reputation as a physics program with particularly strong undergraduate research.

<table>
<thead>
<tr>
<th></th>
<th>Present CSUEB</th>
<th>SFSU</th>
<th>CSU Stanislaus</th>
<th>CSU Chico</th>
<th>UC Berkeley</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lower Division</strong></td>
<td></td>
<td></td>
<td></td>
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<tr>
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<td>18</td>
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<tr>
<td>Chemistry</td>
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<td></td>
<td>15</td>
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<tr>
<td>Calculus</td>
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<td>18</td>
<td>18</td>
<td>18</td>
<td>12</td>
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<tr>
<td>Linear Algebra</td>
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<tr>
<td><strong>Upper Division</strong></td>
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<td></td>
</tr>
<tr>
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<td>10.5</td>
<td>6</td>
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<tr>
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<td>7.5</td>
<td>4.5</td>
<td>9</td>
<td></td>
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<tr>
<td>Analytic Mechanics</td>
<td>6</td>
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<td>Thermal Physics</td>
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<td>9</td>
<td>12</td>
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<td>6</td>
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<td>Selected Topics/Electives</td>
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<td><strong>TOTAL</strong></td>
<td>105</td>
<td>106.5</td>
<td>105</td>
<td>105</td>
<td>87</td>
</tr>
</tbody>
</table>

Table 2.2.3 Comparison of the BS degree in physics at CSUEB to other Northern California Universities.
Comparison with other institutions

Table 2.2.3 above a comparison of the curriculum for the equivalent of our B.S. degree at present to three other CSU campuses and the University of California at Berkeley (technically a B.A. degree, only degree offered at UC Berkeley), units are scaled to quarter-system-equivalent. We see that our curriculum is comparable to the other institutions, and reflects our strong emphasis on hands-on laboratory instruction and commitment to a strong core of the foundational physics topics (analytic mechanics, thermodynamics, quantum mechanics, and electromagnetism).

One important difference between our program and the other CSU physics programs is the combination of the lower division General Physics and the gateway upper division Modern Physics course. SFSU, CSU Stanislaus, and CSU Chico devote a total of 25.5, 19.5, and 27 units to this combination of courses whereas at present our department devotes only 15 units to this combination of courses. The need for a modern physics course was raised in the previous outside reviewer report in 2005. This need is our first priority for curriculum improvement as described in our 5-year plan.

New Physics Education Option

The department recently created a Physics Education option within the BA degree. The purpose of this option was to design an undergraduate curriculum specifically for students interested in becoming high school physics teachers. The faculty felt strongly that this should be a “real” physics degree, not an overly watered down version of our regular degree. However, high school teachers need a broader exposure to the sciences than is provided by our regular program. Therefore the new option in physics education included courses in other sciences like biology and earth science. In order to manage the course load, we did eliminate a few advanced theory courses, but retained the main foundations of our current program. The option became available to students in the Fall of 2010, so there has not yet been a chance for students to work through the program. However, due to the active Math and Science Teacher Initiative on campus (in which physics faculty participate) we have seen an increase in the number of students expressing an interest in becoming high school physics teachers.

A related initiative in the physics department has been the creation of a new upper division online lecture and on-ground laboratory course (PHYS 3011, 3012 - Foundational Physics) designed for future middle school science teachers. These courses are not intended for physics majors, rather for liberal studies majors who plan on becoming K-8 teachers and who are interested in specializing in science. These courses build on the lower division physics lecture and lab (PHYS 1700, 1780 - Elementary Physics) already required for liberal studies majors. These two courses are part of a suite of science courses in biology, chemistry, and earth science as well as physics that together make up a proposed certificate program. Besides current undergraduates majoring in liberal studies, we expect practicing K-6 teachers to pursue this program so that they can become middle school science teachers.

New Physics Minor

In the fall of 2009 the department revised its physics minor with the objective of creating a more flexible minor that had the potential to interest a greater number of students. The previous minor had a rigid structure of classes and a high number of units (47). No student had completed the minor in the last 10 years. The revised minor is composed of 28 units and offers students
much more flexibility. In addition to the introductory physics sequence, students choose any three upper division theory courses and one upper division laboratory class. It is hoped that this flexibility and manageable class load will encourage students in other disciplines to pursue the physics minor.

Assessment Plan for Program

The department of physics has developed an assessment plan for students pursuing both the BA and BS degrees. This plan is based on the three learning outcomes shown below. A brief description of our progress in carrying out this plan is given below, while more detailed assessment tools and data can be found in Appendix C.

1) Students will have a general understanding of the fundamental principles of physics.

For the past couple of years we have been measuring this outcome in our introductory physics sequence (PHYS 1001,2,3) for physics, engineering and chemistry majors. This is accomplished with pre- and post-tests. Students are given a qualitative exam on the first day of class of each quarter covering several core ideas. The same exam is given to the students on the last day of the quarter. This year we have expanded this pre- and post test to our introductory physics sequence for life science majors. We continue to see strong improvement in the students understanding after they have taken these courses.

2) Students should be able to effectively perform a physics experiment, analyze the acquired data, draw meaningful conclusions, and communicate these results to their peers.

We continue to measure this learning outcome in our upper division physics laboratories: PHYS 3281 Experimental Physics and PHYS 3283 Advanced Laboratory. The department has a standardized rubric for which we evaluate student’s abilities to communicate scientific ideas.

3) Students have in-depth knowledge of the foundational subjects in physics (primarily analytical mechanics, quantum mechanics, thermodynamics and statistical mechanics, and electrodynamics).

Students enrolled in our capstone class, PHYS 4950 are given a physics GRE exam at the end of the quarter. We administer the same exam each spring, and are able to compare the results, one year to the next. There are however, two complications when looking at this data: there are a very small number of students taking the class so variations from year to year are not necessarily statistically significant, and students often take this course as juniors in order to help prepare them for the GRE when applying to graduate school. The students that are juniors have not had half of the upper division curriculum, therefore this is not a good measure of their overall knowledge of physics that has been learned in our program. We are looking into changing the prerequisites for this course so students must take this course as a senior.
2.3. Students, Advising, and Retention

<table>
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<td>3</td>
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<td>Fall Quarter</td>
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<td>C. Faculty</td>
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<td>Tenured/Track Headcount</td>
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<td>1. Full-Time</td>
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<tr>
<td>2. Part-Time</td>
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<td>Lecturer Headcount</td>
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<td>4. Full-Time</td>
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<td>5. Part-Time</td>
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<td>4</td>
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<tr>
<td>6. Total Non-Tenure Track</td>
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<td>3</td>
<td>4</td>
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<td>7. Grand Total All Faculty</td>
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<td>7</td>
<td>8</td>
<td>8</td>
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<td>Instructional FTE Faculty</td>
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<td>2.4</td>
<td>2.1</td>
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<tr>
<td>10. Total Instructional FTEF</td>
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<td>6.1</td>
<td>5.6</td>
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<td>Lecturer Teaching</td>
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<td></td>
<td></td>
<td></td>
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<td>11. % Lecturer/Total Instructional FTEF</td>
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<td>32.4%</td>
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<td>39.1%</td>
<td>38.2%</td>
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<td>12. FTES Taught by Lecturer</td>
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<td>48.1</td>
<td>90.1</td>
<td>76.7</td>
<td>81.9</td>
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<td>13. % FTES Lecture/FTES Generated</td>
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<td>42.8%</td>
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<td>39.9%</td>
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<td>D. Student Faculty Ratios</td>
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</tr>
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<tr>
<td>5. Upper Division</td>
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<td>12.3</td>
<td>16.6</td>
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<td>6. Graduate</td>
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<td>7. Number of Sections Offered</td>
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<td>31</td>
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<td>8. Average Section Size</td>
<td>23</td>
<td>25</td>
<td>24</td>
<td>26</td>
<td>30</td>
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</tbody>
</table>

Table 2.3.1 Department data for 2005 - 2009.
Over the past five years the Department of Physics has increased the number of majors, increased its overall teaching load, and increased the efficiency at which it teaches its classes. The number of physics majors has increased from 21 to 28. During the previous five year period the number of majors was closer to 10. The department has seen a huge growth in its teaching load, primarily in general education and service courses over the past five years. The total FTES taught by the department has grown by 125% since 2006 (Chart 2.3.1). At the same time the number of TT faculty has decreased from 4.5 to 4. The department managed this strong growth in large part by increasing its SFR. In 2005 the SFR was 16.8, while in 2009 it was 36.8 - an increase of 120%. While this increased efficiency has allowed the department to weather tough economic times, it is not sustainable in the long run. We are regularly teaching classes over their intended capacity which ultimately diminishes the quality of instruction that students receive. An SFR of 36.8 is an especially acute problem when one considers that a large fraction of our teaching load is in laboratory courses that demand a smaller student faculty ratio.

![Annualized FTES](chart.png)

Chart 2.3.1 FTES taught by the Physics Department over the past five years.

**Advising**

With a small number of majors, advising does not pose a significant challenge. The department chair serves as the undergraduate adviser to all students. At the start of each year the chair sends out an email encouraging students to make an appointment for advising, as well as giving generic advising for each grade level. Faculty regularly interact with students, and much advising is conducted on an informal basis.

**Recruitment and Retention**

The department takes part in recruitment activities on campus such as the major/minor fair and the major overview as part of the general education first year learning communities. We also participate in off-campus events such as the Las Positas College Major Fair. This Fall we
hosted our first open house in conjunction with the Department of Chemistry in order to give students a chance to learn more about the department. The event was advertised to CSUEB students, students at regional community colleges and local high schools. The physics program is also advertised as part of our Math and Science Teacher Initiative to recruit and train more physics teachers. We have a staff member who regularly visits community colleges to advertise our programs and we have quarterly workshops on campus for students interested in becoming math or science teachers.

Due to the small size of the department there is a large amount of interaction between faculty and students which aids student retention. If a student is struggling either inside or outside the classroom, faculty are available to help. A significant fraction of our majors are involved in faculty directed research projects, which further helps connect them with the department. The largest challenge in retaining students seems to be connected with the weakness of their academic preparation. We have tried to craft a rigorous, yet undergraduate level appropriate curriculum for our program here at CSUEB. Unfortunately, many students enter our program without college level study skills. While the faculty try to mentor these students, some decide that physics is not the subject for them.

2.4. Faculty

<table>
<thead>
<tr>
<th>Position Requested</th>
<th>Date Requested</th>
<th>Faculty Hired</th>
<th>Start Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atomic Physics</td>
<td>2004</td>
<td>Dr. Derek Kimball</td>
<td>Fall 2005</td>
</tr>
<tr>
<td>Solid State Physics</td>
<td>2007</td>
<td>Dr. Erik Helgren</td>
<td>Fall 2008</td>
</tr>
</tbody>
</table>

Table 2.4.1 - Faculty requests and hires since last review.

The department of physics has completed two searches since the last five year review. The first of these was an atomic physics position requested and granted in 2004, and the second was a solid state position requested and granted in 2007. The department has recently requested another hire which will be discussed in section 3.3. Past and current tenure-track requests are supplied in Appendix D.

In the previous five year period the department had one failed search, and two newly hired faculty leave after one and two years. Since then the department has been much more successful in retaining faculty. Dr. Singley who was hired in 2003 was awarded tenure and promoted in 2009, and Dr. Kimball was awarded tenure and promoted in 2010. Dr. Helgren is now in his third year and is making good progress in all areas of his work.
2.5. Resources

Library

- Research Databases/Journal Access

Students in the Physics Department are encouraged to participate in undergraduate research. This often involves literature searches. The Research Databases provided through the CSUEB Library for Physics are:

- American Institute of Physics Journals Online (Scitation)
- ScienceDirect
- Web of Science
- Wiley Online Library

Currently, these databases allow access to articles from important journals such as Nature, Science, the journals from the American Institute of Physics and the journals from the American Physical Society amongst others. It is unclear whether the CSUEB Library provides access to all the academic journals needed for course and lab-based research for the various Physics faculty. However over the last five year time frame access to even these most basic journals has been sporadic and some faculty have indicated that necessary journals (e.g. various Optics Journals) have never been available at CSUEB. Furthermore, the Web of Science database extends back only a few years, limiting its usefulness.

- Textbooks on Reserve Program

Every tenured/tenure-track faculty member in the Department of Physics has donated personal, extra copies of the textbooks being used in their courses to this program so students have access to them at the library for various time periods. Though this program is intended to help students obtain access to the textbooks when on campus, we do not have statistics on how many students check out these textbooks, whether those students rely solely on the textbook on reserve and how those students perform relative to students who have their own copy of the textbook and/or do not use this program.

- Wireless access for laptops

Over the past five years there has been a flux in the number of computer labs accessible to the students here at CSUEB, with a dramatic cut in said number over the past two years during the economic downturn. However the faculty members in the Department of Physics strive to inform their students about the increased wireless access for students with laptops, as wireless accessibility has increased steadily over the past five years in contrast to the number of computer labs. We have no summative records of how the flux in the number of computer labs on campus has impacted students in Physics courses, nor of how many students use the wireless access for Physics coursework.

- Loaner Laptop Program

This is a program instituted by CSUEB and which the Department of Physics faculty members have encouraged many of their eligible students to use. This program allows financially qualified students to borrow a laptop for up to a quarter. The Department of Physics has switched to an online homework submission system called Mastering Physics and the Loaner Laptop Program is
intended to provide greater accessibility for students who might otherwise not have access to a computer. It is unclear how many students enrolled in Physics courses are impacted by this program.

**Information/Instructional Technology**

- **Blackboard**

  Blackboard is a web-based portal accessible to students and faculty at CSUEB. All tenured/tenure-track faculty members use this system extensively. It is intended to facilitate alacrity in teacher student communication through online grade posting, web-based real-time chat rooms regarding the course, discussion boards for students and faculty and an online database for course content. Each Physics Faculty member posts syllabi and course content on course specific sites on the CSUEB Blackboard website. The online courses taught through the Physics Department are run entirely through Blackboard. It is unclear how well this system performs relative to other web-based portals such as Sakai® or how whether this system has improved the overall performance of students since its inception.

- **Lecture Capture “East Bay Replay” Scot Gresham-Lancaster**

  Over the past five years, every tenured/tenure-track faculty member in the Department of Physics, has used the Lecture Capture program referred to as “East Bay Replay” headed by CSUEB’s Information Technology Services and Dr. Scot Gresham-Lancaster, in particular for high enrollment Introductory Physics lecture courses. Students can listen to the recorded lectures by selecting a link on the course specific Blackboard website. Hardware varies by classroom; e.g. Video capture of a small whiteboard is synchronized to the recorded lecture and if any other media is provided during the lecture, i.e. Powerpoint slides, videos etc., this too is displayed to the students concomitantly with the audio. Though anecdotal responses from students suggest this service is popular, it is unclear whether this system is being used as an alternative to attending lectures or simply as a supplement to attending lectures as is its intent.

- **Mastering Physics – online homework system for Introductory Physics courses**

  During the last five years the Physics Department has implemented an online homework system called Mastering Physics (a Pearson product) for the Physics 2700 and 1000 sequence introductory courses (algebra and calculus based respectively). This system was chosen to work with the textbooks being used, i.e. Knight’s Physics for Scientists and Engineers and College Physics. Furthermore, Mastering Physics was chosen as the Chemistry Department also has switched to the online homework system Mastering Chemistry also from Pearson, thus relieving the pressure on students from learning multiple web-based homework systems. The Physics Department faculty members have noted marked improvement in homework learning, specifically due to the real-time feedback provided to students when they work on problems; however some hardware features constrict faculty teaching styles.

- **Clickers (Purchase of a Clicker remote is mandatory for incoming freshmen in the “clusters”)**

  Department of Physics faculty members teaching cohorts of incoming freshmen participating in the CSUEB Freshmen Learning Communities or “clusters” have implemented the use of “Clicker” questions during lecture, a formative assessment tool. Clicker multiple choice questions are posed throughout the lecture and students can anonymously answer using a remote
clicker they bring to class. The anonymity facilitates participation of reserved or less-than-confident students. The Clicker questions and responses are recorded for formative assessment. However instructors have been hesitant to implement this tool in non-cluster classes, as the cost of purchasing the hardware seems to be an extra financial burden on the students.

Assistive Technology and Services

- Student Disability Resource Center (SDRC)

Each Physics Department faculty member announces on the first day of class and/or provides information on the course syllabus about this CSUEB sponsored center. They provide academic accommodations to qualified students with disabilities. Their counselors determine accommodations on an individual basis after reviewing current professional documentation and meeting with the student. The purpose of such accommodations is to provide equal access to classroom programs and campus activities in a manner consistent with Section 504 of the Rehabilitation Act, the Americans with Disabilities Act, associated California laws and regulations, and CSU policy.

- SCAA

The Student Center for Academic Achievement (SCAA) has never provided tutoring or direct assistance to students with respect to their Physics coursework, even though there is and has been an extremely high need.

Any other resource needs relevant to the program

- Instructional Lab Supplies and Equipment

For the past five years the Physics Department has been able to use approximately $1000 from the department’s general fund to purchase supplies and to replace equipment in the instructional labs. No dedicated laboratory equipment and supply funding has been provided by CSUEB. Unfortunately this is far less than the approximately $10,000 annually needed to maintain and modernize our instructional lab over a reasonable timeframe (estimates of reasonable timeframe include replacing the complete list of current lab equipment over 10-20 years).

- Instructional Software

Instructional software, for modeling, data analysis etc. is indispensible in today’s academic setting. Some of the most important software used in the Physics Department for instructional purposes are: Mathematica, MultiSim and Labview. The CSUEB Information Technology Services group has unfortunately only been able to provide one of these three for our department and external funding and the department’s general fund have been used to purchase the others.

1. CSUEB has purchased a campus-wide site license for Mathematica, and this software is used extensively by Physics Department faculty and their students in many courses.
2. In 2009 a generous donation from a former faculty member, Dr. John Giles, was made to purchase MultiSim, circuit modeling software from National Instruments.
3. The Department of Physics has used money from its general fund to purchase a site license for Labview software for use in the upper division labs.

- Internal CSUEB Faculty Research Assistance

Over the past five years, the faculty in the Department of Physics have consistently applied for and been awarded CSUEB sponsored Faculty Support Grants; typically funding on the order of $4000 in the form of a mini grant, summer salary and/or release time during the academic year. This program was cut during the recent economic downturn with the last round of grants awarded to faculty researchers in 2008.

<table>
<thead>
<tr>
<th>AY</th>
<th>PI</th>
<th>Award</th>
<th>Proposal</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>Dr. Singley</td>
<td>$5000</td>
<td>Exploring the Phase Diagram of Na₅CoO₂</td>
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<tr>
<td>2006</td>
<td>Dr. Kimball</td>
<td>Release time &amp; summer salary</td>
<td>Gravitational Dipole Moments and the Origin of the Matter/Antimatter Asymmetry of the Universe</td>
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<tr>
<td>2006</td>
<td>Dr. Kimball</td>
<td>Release time &amp; summer salary</td>
<td>Development of an Ultra-Sensitive Atomic Magnetometer for Tests of Fundamental Physics</td>
</tr>
<tr>
<td>2007</td>
<td>Dr. Singley</td>
<td>$5000</td>
<td>Investigating Alternative Energy Resources</td>
</tr>
<tr>
<td>2008</td>
<td>Dr. Helgren</td>
<td>$4700</td>
<td>Modeling of Negative Index of Refraction Metamaterials</td>
</tr>
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</table>

- External Funding

The faculty members in the Physics Department have made a major push in seeking external funding over the past years. The list of external grants is shown in Table 2.1.1 above, totaling over $1,880,000 awarded to members of the Physics Department over the last five years.

2.6. Units Requirement

The BS degree in physics requires 105 major units and 64 GE units for a total of 169 units. The BA degree in physics requires 87 major units and 64 GE units for a total of 151 units.
3. Five-Year Plan

3.1. Curriculum

Changes in the BA and BS degree in Physics

Add Physics 2004 to requirements for Physics B.S. and B.A. degrees, and Physics minors

We have recently added a new fourth quarter of General Physics, Physics 2004, a 4-unit lecture with a 1-unit laboratory section. Physics 2004 will be offered for the first time in Fall 2011. The additional quarter of General Physics will be a significant improvement in our lower division Physics curriculum:

1. Most comparable institutions offer either three semesters or five quarters of General Physics, plus a Modern Physics course (see Table below, all units scaled to the quarter-system-equivalent). The new 4-quarter sequence (Physics 1001, 1002, 1003, and 2004) will enable us to spend more time on each topic and better engage students using active learning techniques (which considerably slow the pace at which material can be covered).

<table>
<thead>
<tr>
<th>Lower Division</th>
<th>Present CSUEB</th>
<th>Proposed CSUEB</th>
<th>SFSU</th>
<th>CSU Stanislaus</th>
<th>CSU Chico</th>
<th>UC Berkeley</th>
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<table>
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<th>Upper Division</th>
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<th>Proposed CSUEB</th>
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<th>CSU Stanislaus</th>
<th>CSU Chico</th>
<th>UC Berkeley</th>
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<td>Differential Equations</td>
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<td>4</td>
<td>4.5</td>
<td>10.5</td>
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<tr>
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<td>7.5</td>
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<td>Analytic Mechanics</td>
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<td>4.5</td>
<td>6</td>
<td>4.5</td>
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<tr>
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<td>4.5</td>
<td>4.5</td>
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<tr>
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<td>6</td>
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<tr>
<td>Experimental/Advanced Lab</td>
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<td>4.5</td>
<td>3</td>
<td>4.5</td>
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<tr>
<td>Quantum Mechanics</td>
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<td>9</td>
<td>4.5</td>
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<td>9</td>
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<td>Electromagnetism</td>
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<td>9</td>
<td>9</td>
<td>9</td>
<td>6</td>
</tr>
<tr>
<td>Theoretical/Mathematical Physics</td>
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<td>4.5</td>
<td>4.5</td>
<td></td>
<td></td>
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<tr>
<td>Selected Topics/Electives</td>
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<td>4.5</td>
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<td>1</td>
<td>1.5</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

| TOTAL          | 105          | 110            | 106.5| 105            | 105       | 87          |

Table 3.1.1 Current and proposed physics program at CSUEB compared to other Northern California Universities.
2. Physics 2004 will serve as a sophomore-level course that helps Physics majors transition from lower-division physics courses to upper-division physics courses, where the mathematical rigor, subtlety of physical arguments, and expectations of students are far more advanced.

3. The Physics 2004 laboratory will allow students, who have already mastered basic laboratory techniques in Physics 1001-3, to perform more open-ended, exploratory experiments that will better develop essential technical and creative problem-solving skills.

The first essential step in our curriculum development plan is to incorporate Physics 2004 into the requirements for the Physics B.S. and B.A. degrees, as well as for the Physics Minor. Physics 2004 will address many of the needs of the Physics majors and minors in terms of problem-solving skill development for upper division coursework, improve retention, and enable more attention to be paid to subjects in modern physics such as relativity, nuclear, and particle physics that presently have very little coverage in the curriculum.

Modify mathematics requirements

Add the fourth quarter of the calculus sequence (Math 2305: Calculus IV) to the B.S. and B.A. degree requirements. Essential mathematical skills for upper division physics related to vector calculus are developed in this new course offering. Drop Partial Differential Equations (Math 4361) from requirements, since the subject material covered in this course is generally addressed as needed in the appropriate upper division physics courses. Students typically are unable to take the course until after they have taken the upper division physics courses which use partial differential equations.

Capstone Projects for Majors

Based on the recommendation of our outside reviewer, the department will examine the feasibility of requiring a capstone project for all majors. Currently, a majority of physics students participate in an out of class project with a faculty member. Most of the time this involves working in a faculty members research laboratory. This often leads to students giving talks or poster presentations at regional or national conferences and occasionally leads to a publication in a peer reviewed journal for the student. The idea would be to formalize these types of activities, requiring all graduates to complete an out-of-class project and to present their results in a talk and or paper. Students would receive academic credit for the project and it would serve as a culminating experience that would integrate several of the skills and knowledge that the students acquired in our program. Students could choose a basic or applied project or alternatively a project based on physics education for those interested in teaching. The faculty will consider adding the capstone project as a requirement to the major in 2011-12.

Seminar Class

The department of physics currently holds an informal seminar series on a somewhat sporadic basis. During some quarters we will have several visitors speaking at department seminars, while during other quarters no seminars will be held. At the suggestion of the outside reviewer, the department will consider making the seminar series into a formal class. Students would sign up for a 1 unit class that would meet for one hour a week. A faculty member would be assigned to the course and earn 1 wtu. The faculty member would be in charge of arranging
for weekly seminars during the quarter. Students would be required to attend and have homework based on the weekly talks. This type of arrangement would have several benefits: 1) a faculty member would have time (and the responsibility) to set up the weekly seminars, 2) students would be exposed to a wide variety of physicist and would therefore have a broad exposure to different physics careers, 3) the department would have a higher profile on campus through the regular seminars (which would remain open to the public), and may be able to attract more majors, and 4) the department could cultivate a network of physicists that could act as an advisory panel for the department as well as potential donors. The department will try out this class in the framework of our current PHYS 4250 - Selected Topics course in 2011-12. If successful, the department will consider creating a new course and major requirement.

**Develop an Engineering Physics major**

After implementing the above changes to the Physics B.S. and B.A. degree programs and Physics minor programs, we plan to turn our attention to development of a new degree program in collaboration with the Department of Engineering. The Physics program is excellently suited for students desiring to continue study of physics at the graduate level and for students seeking to teach physics at the high school level, but there remains a need for development of program elements tailored specifically to those students planning to enter employment in industry directly after graduation with a B.S. or B.A. degree. Furthermore there is anecdotal evidence from discussion with engineering majors that an engineering option with a more technical focus is desired. The proposed Engineering Physics B.S. degree would meet both these identified needs.

In Appendix E we compare the course requirements of several Engineering Physics programs (from UC Berkeley, University of the Pacific, and CSU Stanislaus) and offer an initial possible proposal for our own program. The actual program proposal will be developed in collaboration with the Engineering Department and in consultation with local high-tech industry. One important consideration, especially during the present economic and budget climate, is the cost of such a program to the university. There is a fee associated with ABET accreditation of between $5-10k. Otherwise, it appears that the cost is minimal as there are few if any new courses necessary and we will be taking advantage of economy of scale by attracting new students to under enrolled courses.

The Physics department as a whole will be responsible for crafting this new program in collaboration with the Engineering department. Starting in 2011 we expect to have initial discussion and meetings with Engineering Department and industry experts to map out the potential curriculum. We will survey current engineering and physics students in our General Physics course for interest. By the fall of 2012 we will begin development of any necessary new courses and if research and development indicates promising direction, submit a proposal for the new option by the spring of 2013. By the fall of 2014 we would be offering courses and enrolling students in the program.

**General Education**

The department foresees only minor changes to its general education offerings. The department has several new upper division GE courses that fulfill the B6 requirement. Some of these like PHYS 3750 - Biophysics have become very popular and are now offered every quarter. Others like PHYS 3710 - Solar System Astronomy have only been offered a couple of times with marginal enrollment. Finally our PHYS 3720 - Stars and Galaxies course has not yet been offered. We will continue to develop these latter courses and attempt to build our enrollment by
advertising the courses on campus. We also plan on considering the option of turning our PHYS 3011 - Foundational Physics course into an upper division GE course. While this will potentially help sustain the course by increasing enrollment, we will need to investigate whether we can balance the needs of GE students with the main goal of the course: training future middle school teachers. This issue will be addressed by the faculty in the 2011-12 academic year.

In the lower division GE program we plan on again submitting several proposals for “clusters” as part of the freshman learning communities. During the past three year cycle we have offered 1 majors cluster and 3 non-major clusters. We plan on having a similar level of engagement in the cluster program in the future. Finally, we plan on converting our PHYS 1800 - Astronomy course to an online format. There is a high demand for online GE courses, and we have spoken with colleagues at another institution that have had success offering astronomy in the online format. We will send our proposal to the college curriculum committee during the spring of 2011, and plan on offering the course in the new format in 2011-12.

Service Courses

The department has no plans to alter its offering of service courses in the next five years. A critical issue however will be how the department is able to manage the strong enrollment growth that is occurring in these courses. This topic will be discussed below in section 3.2.

3.2. Students

Skills and Learning Objectives

The department plans to conduct a review of its learning objectives for the program in addition to a focus on the particular skills that we expect students to acquire. We will map these learning objectives and skills to our current curriculum to ensure students are learning what they need to when they need to. As part of this project we will examine our assessment plan to be sure we have an accurate way to measure whether or not students are meeting the learning objectives. Much of this work has already begun, and the focus in the next year will be to formalize and document the results.

Growth in Major

As indicated in table 2.3.1, the number of majors has grown over the past five years. However, the physics major continues to be one of the smaller programs on campus. This is neither surprising nor unusual. In fact the average number of upper division students in enrolled in Bachelor’s degree only physics programs is 12 (www.aip.org/statistics), about our current level. Table 3.2.1 below compares upper division physics enrollment for programs throughout the CSU. Data are for the fall term of 2009 and from the American Institute of Physics and the CSU Chancellors office. At first glance the number of upper division students at CSUEB is well below both the mean and median for the CSU. However, taking into account the different sizes of the campuses gives a somewhat different picture. The last column of the table shows the number of upper division physics majors per 1,000 undergraduates enrolled at each campus. The average of 1.65 is inflated by just a handful of schools such as Cal Poly San Louis Obispo, Sonoma State, San Diego State, and Chico. A better metric of the system is the median value of 1.26 students. In this manner it is apparent that enrollment at CSU East Bay physics programs is in line with the CSU system as a whole.
Table 3.2.1 Enrollment comparison in physics department throughout the CSU.

While not unusual, the small size of the physics program at CSU East Bay does have some drawbacks. Foremost is that in order to maintain a viable SFR the program is limited to offering upper division courses every other year. The result is that students have no flexibility in when they can take courses, all of our courses have a mix of juniors and seniors which effect how we can teach, we are unable to offer any elective courses, and faculty workload is effectively increased as they can only repeat courses every other year. Increasing our enrollment is therefore a priority for the program.

The good news from table 3.2.1 is that it is not unreasonable to think the department could increase its enrollment by a factor of two or even three. We are setting a five year goal to increase the number of majors to above 40. This should allow us to offer an annual class schedule. In order to accomplish this we will implement the following initiatives, some of which are already underway.

- Maintain a high quality and rigorous curriculum. With the turnover in faculty in the last 5-10 years, there has been a paradigm shift in how we view our curriculum. The new faculty are not content to offer a “physics light” version of an undergraduate degree. Rather we feel that it is our job to offer quality instruction at a level that is similar to top CSU’s or the UC. The student response to this increased rigor has been nearly unanimous:
they are excited to be learning physics and are raising their performance as we raise our standards.

- Provide the opportunity for research experiences for all undergraduates. Until this past decade, there has been little to no research done in the department. Now there are active research programs in Atomic Physics, Material Science, and Solid State Physics. Faculty are not only pursuing research projects that involve undergraduates, but are bringing in external grants that allow for the purchase of cutting edge technology for our students to be trained on. For the past several years nearly all of our graduates had the chance to work on a research project.

- Develop an Engineering Physics major. In our introductory physics sequence we encounter a number of students who are passionate about physics, but want a major with a more applied emphasis. Most of these students end up in Engineering, but are somewhat unsatisfied since East Bay does not have the traditional Engineering majors like Mechanical and Electrical Engineering. We believe an Engineering Physics degree will appeal to these students' interest in physics while at the same time giving them a degree that is well matched with Baccalaureate level engineering jobs.

- Develop a marketing plan for recruitment. Physics programs that have mounted well thought out and executed marketing plans for their majors have seen a significant increase in enrollment. Perhaps this should not be surprising: marketing works. Using resources available through the American Physical Society we will develop a marketing plan that we can implement on campus. Due to the extreme workload the faculty is already under, and their lack of experience in this area, this is perhaps the most challenging initiative. Nevertheless, this issue is so important for the long term health of our program that we will make it a priority early in the next five year cycle.

Growth in FTE and Teaching Load

The department has experienced a 125% growth in its FTES taught over the past five years (see Chart 2.3.1). Over that same period the number of full time tenure track faculty has decreased by 11%. This has led to the majority of our classes now being taught by part-time lecturers. In addition to this overall strong past growth, there are a few areas where we anticipate additional growth in the immediate, or near term.

- PHYS 2701, 2702, 2703 - This Introductory Physics sequence intended mainly for life science majors has grown by 71% over the past 5 years. We now typically have close to 250 students in two sections. These large lectures that are well over the official course capacity create significant obstacles to student learning. Over the past two decades a plethora of physics education research has made it clear that students learn best when they are actively engaged in the learning process, rather than passive listeners. While the physics faculty have made efforts to introduce active learning methodologies into our lectures, the large lecture hall format significantly impedes these efforts. Our goal over the next two years is to reduce the average lecture size of these courses to no more than 60 students. In order to meet the student demand this will require additional sections. We plan on accomplishing this in two ways. In the 2011-2012 academic year we will offer a new course sequence that starts in the winter and ends in the summer. This is something the department has done in the past and is done by both the biology and chemistry departments for their introductory sequences. The subsequent year we will evaluate the student demand and potentially offer a third section of
the course starting in the fall, or a second section starting in the winter. The budget implication of this course of action is not quite as bad as it may seem at first pass. For the past couple of years at least one of our sections has exceeded 120 students so that the college was forced to award the instructor double units. Therefore adding another section of these classes costs nothing. Additionally it is worth noting that offering these classes with an enrollment of 60 still yields a very productive SFR of 48 for the course.

- PHYS 1001, 1002, 1003, 2004 - This is the General Physics sequence taken by physics, chemistry, and engineering majors. The class has grown over 120% in the past five years. It is now taught near its capacity, and will require additional sections to sustain the past growth. It is worth noting that CSUEB has a relatively young engineering department that is still in a strong growth mode. Indeed much of the growth in General Physics has come from a large increase in the number of engineering majors taking the course (see Chart 2.2.1 and Table2.2.2). As the engineering department continues to grow, the departments that help serve its students will also need to grow concomitantly.

- Annual upper division courses - About ten years ago the department of physics experienced a very strong decrease in the number of majors enrolling in the program. To deal with this, the department started offering upper division courses only every other year. While this did help the department maintain a satisfactory SFR, the downside was the department was no longer able to distinguish between junior and senior level courses. Additionally, upper division topics could no longer be taught in a logical order, since half the class would likely not have the necessary pre-requisites. In the last 5-year review one of the main recommendations of the outside reviewer was to bring back the annual upper division courses. The department has made significant progress in increasing the size of the major, and we anticipate being in a position to offer annual upper division courses in the next few years. This will significantly increase the teaching load in the department and will not be possible without additional full time faculty.

3.3. Faculty

Based on the strong growth in our FTES teaching load (chart 2.3.1) and the specific near term growth areas outlined above in section 3.2, we expect the department to grow from 4 TT faculty to 6 TT faculty in the next five years. The department has recently submitted a proposal (see appendix D) for a new hire in 2012 that has been supported by Dean Leung. We expect to hire in the area of atomic physics, building on the impressive program that Dr. Kimball has developed in this area. We expect the second position would be for 2014 or 2015 when the number of majors in the department has grown so that we are once again offering upper division physics courses on an annual schedule.

A more general issue concerning faculty is the current workload which is at an unsustainable level. In addition to a high teaching load of 36 wtu per year, faculty are expected to remain professionally active, mentor students, develop new curriculum, and participate in faculty governance at the department, college and university level. The strong growth in enrollment outlined in this report in a time of declining budgets has been accomplished by enrolling more students in every class and hence increasing the faculty’s teaching load. At the same time the department’s relatively young faculty are under pressure to write and manage grants in order to stay professionally active and provide outside of the classroom learning
opportunities for our students. While in the short term the department has been very successful at managing efficient teaching and grant production (see Tables 2.1.1, 2.2.1, and 2.3.1), over the long term it is unlikely that this can continue. Also there are areas that have clearly suffered over the past five years. A significant fraction of the physics curriculum involves hands-on laboratory work. The development and maintenance of the laboratory curriculum takes a large amount of time that has not recently been available. The result is that a critical part of our physics curriculum is in a state of deterioration.

Finding solutions to these workload issues will not be easy and will require resources from the University. In part, hiring more tenure track faculty into the department may ease some of these problems. With additional faculty the responsibility of developing curriculum and mentoring students could be spread out over a larger group. However, the general issue of what it is that faculty are expected to do outside of the classroom and are they being given the appropriate amount of time to accomplish these tasks needs to be taken up by the University as a whole. One idea that has been successfully implemented on other CSU campuses is to give faculty who are engaged in a professional activity for which they are able to bring external funding to the campus a reduced teaching load. The department understands that the Provost’s office has convened a faculty committee this year to examine these ideas and we will be looking forward to seeing its recommendations.

3.4. Other Resources

Of greatest concern to the Physics Department is the quality of the hands-on lab experience for students both in the introductory Physics courses and the upper division courses. As indicated in the self-study, no dedicated funding model is in place to maintain or upgrade these aforementioned labs. The following is a list of efforts already underway as well as items that need to be addressed over the next five years to provide high quality lab experiments to the Physics Department here at CSUEB.

- Though not a dedicated funding model, this year the Provost has issued a request for proposals for instructional and research equipment. The faculty members in the Physics Department submitted five requests (see appendix F for full proposals) to the dean in December of 2010 and decisions on the proposals will be made by Provost James Houpis by the spring quarter of 2011. The five proposals submitted by the Physics Department faculty and totaling $254,902, are listed in rank order (as voted on by the lecturers and tenure-track faculty in the Physics Department):

  1. Replacement Equipment for Lower Division Physics: $43,558
  2. Equipment for New Lower Division Physics Laboratory Sections: $97,247
  3. Purchase of Alpha-SE variable angle spectroscopic Ellipsometer: $51,830
  4. Purchase of 16 inch telescope with CCD: $43,900
  5. Purchase of Linerg/Blue multipurpose box furnace: $18,367

As unanimously agreed upon by the Physics faculty members, replacement and the purchase of new laboratory equipment was of highest priority for this one-time funding
opportunity. The purchase of an ellipsometer, a telescope and box furnace would each have a dual-purpose as upper-division lab equipment and tools to be used in faculty research.

- In 2010 CSUEB hired a new Provost, who is installing a new funding architecture here at CSUEB with one of his major goals being, providing more funding to Academic Affairs, which oversees classroom instruction. Over the next five years the Physics Department should work as closely as possible with the Dean of the COS and Provost Houpis so as to establish a funding model to maintain and replace lab equipment under this new funding architecture.

- In an effort to provide new, external funding sources for the upper division labs, Dr. Kimball, Dr. Helgren and Dr. Singley are have worked in conjunction with a team in the Department of Physics at UC Berkeley (being selected as finalists by NSF in Dec. 2010) to establish a Quantum Imaging center at UC Berkeley. The Physics Department at CSUEB would be provided resources and funding to develop Advanced Labs for this collaboration over the next 5 years. Each of these labs would then be available to use here at CSUEB for students in Physics 3281 and 3283, the Experimental Physics and Advanced Labs required of all Physics majors. These new labs would allow our students to learn how to use cutting edge industry and research tools. A summary of the proposal is available in Appendix G.

- Within the California State University system, most of the Physics Departments charge students taking a Physics course (typically one with an accompanying lab component) a so-called lab-fee. In many instances, the department also has the discretion to charge a breakage fee should the student damage any of the equipment. Here at CSUEB the Physics Department does not currently charge a lab fee or a breakage fee. The following is a table of comparable institutions’ lab fees.

<table>
<thead>
<tr>
<th>Institution</th>
<th>Range of Fees</th>
<th>Classes where a fee is charged</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSU Chico</td>
<td>$2 - $21 per student</td>
<td>General Physics, Mechanics, E&amp;M</td>
</tr>
<tr>
<td>CSU Channel Islands</td>
<td>$25 per student</td>
<td>General Physics, Introduction to Physics, Introduction to Biophysics &amp; Medical Instrumentation</td>
</tr>
<tr>
<td>San Francisco State University</td>
<td>$4 per student</td>
<td>General Physics with Lab</td>
</tr>
<tr>
<td>San Diego State University</td>
<td>$18 - $25 per student</td>
<td>Fundamentals of Physics, Principals of Physics, Advanced Physical Measurements, Modern Optics Lab</td>
</tr>
</tbody>
</table>

Table 3.4.1 Lab fees charged by other CSU campuses.

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The Department of Physics should work with the Dean and Provost to study the feasibility of implementing lab fees.

**Assistive Technology and Services**

- New programs established at SCAA which provide tutoring assistance in Physics. Faculty should be made aware of this and pass this information on to students in their classes.

During the Fall 2010 quarter, the CSUEB Student Center for Academic Achievement created two new programs to help students succeed and graduate. These programs are part of the Provost’s graduation initiative.

1. **PLUS GROUPS**

   PLUS (Peer Led Undergraduate Study) Groups are study groups assigned to particularly challenging classes. The groups are led by PLUS tutors who have successfully completed the classes. The tutors have been asked to contact the course faculty and to develop PLUS sessions where they provide help with homework and exam preparation, as well as introducing study approaches for each specific class. Information about the PLUS Groups and a schedule of the sessions is found on the SCAA website. This program is similar to the “supplemental instruction” courses already in place in the Physics Department and we should work with SCAA to coordinate our efforts.

2. **eTUTORING**

   Online tutoring is now available for all matriculated CSUEB students. CSUEB has joined the Northwest Consortium of the eTutoring collaborative at Washington State University. Access to this program provides tutoring for subjects not currently available at the SCAA, including: Biology, Chemistry, Physics, and Business. Students may access eTutoring from their Blackboard Desktop, or from the SCAA web page.

**SDRC**

SDRC is now called Accessibility Services. They still provide the same services and are still located in the Library Complex 2400. Department of Physics faculty should be aware of this change and make changes to their syllabi accordingly if necessary.
3. Outside Reviewer(s)’ Report

Please see next page.
Physics Department Review
California State University
East Bay

April 8, 2011

Conducted by:
Lynn Cominsky – Sonoma State University
Introduction

This is the external review report for the California State University Physics department. The Department has four tenure-track faculty, and approximately 28 physics majors, consistent with the average percentage of majors for an undergraduate-only program (http://www.aip.org/statistics/trends/undergradtrends.html).

The on-site review was conducted by Dr. Lynn Cominsky from Sonoma State University in Rohnert Park, California, where she is the Chair of the Physics and Astronomy Department, and also the Director of the NASA Education and Public Outreach group. An active researcher in high-energy astrophysics for over 30 years, she is currently also a scientific co-investigator on several different NASA missions, and a Fellow of the American Physical Society (Forum on Education).

I had the great pleasure to be able to read the Departmental review committee’s self-study report as well as to visit the campus on April 8, 2011. I was able to spend time with almost every member of the department, met with undergraduate student representatives and talked with faculty members and staff in various settings. I also met with Dean Michael Leung. The visit included tours of the research and teaching laboratory facilities, including the newly funded and impressive Femtosecond Optical Frequency Comb and THz Spectrometer laboratory.

I was very impressed by the dedication of the faculty and staff to the well being and achievements of the students. The Department strives very hard to achieve student-centered learning and has worked hard to implement modern pedagogical techniques into even the largest lecture classes. It is clear that the students are greatly appreciative of the teaching quality and the research opportunities within the Department.

I present my most important findings and recommendations in the Executive Summary. Detailed discussions follow the Executive Summary.

Executive Summary

Suggestions and recommendations have been made throughout this report. All of them are gathered here. The order and content are slightly different than in the body of the report to eliminate some repetition and to group recommendations into those that are no-cost (or minimal cost) and those that will require additional resources.

Recommendations requiring new resources:

Scholarly work with undergraduate students, year-round, should be recognized for the prestige it brings CSUEB, for the example it sets, and for the many positive educational impacts it has on the students. I recommend that to facilitate and expand these efforts in the Physics Department, workload credit be given to scholarly work with undergraduate
students. At least 1/3 WTU credit (CS 36) for each supervised research student is my number one priority recommendation.

The rapidly growing enrollments in physics classes and laboratories has created a very difficult situation for the Department (up by 125% in the past five years). At least one new hire in experimental physics is essential to maintain the quality of instruction in core physics courses as well as providing essential research opportunities in physics for undergraduates. At least one new tenure-track hire is my number two priority recommendation.

Equipment for the upper division labs is dated and rather inadequate, and this may also be true for the computers in the lower division labs. I recommend that additional stations and equipment be acquired for the upper division lab and that the experiments be redesigned to incorporate new equipment and modern pedagogy. I also recommend that this lab incorporate the new equipment that has recently been acquired in the research laboratories, in order to offer a wider range of hands-on inquiry based experiences, possibly including biophysics, or other subfields of applied physics. Since completely overhauling the upper division lab curriculum is a very expensive and time consuming process, I recommend incremental improvements as time and resources permit.

Considering the budgetary problems currently faced by the state of California and the CSU system, I find that the staff resources are adequate at the present time. However, supporting the research laboratories will increase the demands on the technician, especially as these relatively new facilities begin to age. Coupled with the growth of the service laboratory classes, additional technician support will be needed in future years, and should be considered as a potential use of future funding tied to FTES growth.

I recommend that when minor capital outlay funds are again available, office space arrangements should be seriously reconsidered, to ensure that no more than two faculty share an office space. And the design of the potential new science building should take into account space for research, lower division laboratories, as well as adequate office space.

Recommendations requiring minimal or no additional resources:

In order to attract more majors, the Department might want to consider adding an algebra-trig B.A. program, designed to work as a double major with other disciplines, and with significantly fewer required upper division theory classes than the current B.A. degree.

The Department should carefully consider the resources required by the addition of an Engineering Physics degree. This is a promising area for Departmental growth, however, in this current budgetary climate, the additional degree program may prove to be too resource intensive. If so, it may be possible, as an intermediate step, to offer a 3+2 program, where the additional two years may be completed at a university with an existing, accredited EE program.
I encourage the Department to require the senior capstone course that has recently been added to the catalog, so that all students can be involved in a distinctive culminating experience. Many undergraduate students now do high-quality research projects, leading to presentations at conferences and publications in refereed journals. While research experience is ideal for students bound for graduate school, capstone experiences should also offer opportunities for design projects (for students with industry goals) and instructional design projects (for students who wish to teach).

Due to the looming shortage of (especially) high-school physics teachers, and the Department's impressive efforts in supporting teacher education, I suggest that the Department consider joining PTEC (the Physics Teachers Education Coalition, http://www.phystec.org/). PTEC membership will raise the Department's national visibility in this important area.

The Department should carefully consider the resources needed before adding a robust Astronomy program to its areas of specialization. New biomedically-oriented labs for the algebra-trig sequence should be considered, in order to differentiate these labs from those intended for majors.

I also encourage the Department to consider offering a weekly colloquium series, as a course for credit (1 WTU and 1 SCU), in order to create a more distinctive identity for the Department, to encourage interactions with the donating public, and to help establish contacts with local industry.

I urge the Department to carefully consider which skills are important for the students at each stage as they progress through the degree programs, and to devise a plan to ensure that all students have the opportunity to develop important technical skills in optics, electronics, computer programming, problem solving, instrumentation interfacing and troubleshooting. I also encourage the inclusion of other skills, such as numerical modeling, data reduction and/or image analysis in this analysis.

The Department should revisit their overall learning objectives, and consider modifying or adding learning objectives such as:

1) Students should know how to use the principles of physics
2) Students should be able to use reasoning and logic to define a problem in terms of principles of physics
3) Students should be able to use mathematics and computer applications to solve physics problems
4) Students should be able to design and/or conduct experiments and/or observations using principles of physics and instrumentation
5) Students should be able to properly analyze and interpret data and experimental uncertainty in order to make meaningful comparisons between experimental measurements or observation and theory
Detailed Discussion

Curriculum:

In order to review the Department’s curriculum, I have reviewed the course catalog descriptions and degree requirements, the Department’s web site, and class sizes for various courses. I also visited the laboratories for lower-division, upper-division and research use, and discussed pedagogy and learning outcomes with the faculty in the Department.

Degree Programs: The Department offers both B.S. and B.A. degrees in physics – this latter degree has a Physics Education option. The relatively small number of majors enhances the Department’s ability to provide individualized instruction and advising. The content for the B.S. degree is very strong, including two quarter sequences in Mechanics and Thermal & Statistical Physics, and three-quarter sequences for Electromagnetism and Quantum Mechanics. The B.A. degree is also rigorous, with not much differentiation from the B.S. degree. A powerful curriculum is one that is aligned with carefully crafted instruction and assessment activities to ensure that students are prepared for careers and graduate study, that depth and rigor are provided to meet national externally generated criteria and that students are engaged in research activities appropriate for their level to advance understanding and maintain motivation. A well-constructed universal senior capstone experience with assessment can bring students and faculty to a higher level of accomplishment.

In order to attract more majors, the Department might want to consider adding an algebra-trig B.A. program, designed to work as a double major with other disciplines, and with significantly fewer required upper division theory classes than the current B.A. degree.

I encourage the Department to require the senior capstone course that has recently been added to the catalog, so that all students can be involved in a distinctive culminating experience. Many undergraduate students now do high-quality research projects, leading to presentations at conferences and publications in refereed journals. While research experience is ideal for students bound for graduate school, capstone experiences should also offer opportunities for design projects (for students with industry goals) and instructional design projects (for students who wish to teach).

The Department is developing plans to offer an Engineering Physics degree, to respond to the need expressed by many students who are not interested in the engineering degrees currently offered by CSUEB. This is a plan which could greatly increase the number of potential physics majors, and is a promising area for future departmental growth.

The Department should carefully consider the resources required by the addition of an Engineering Physics degree. This is a promising area for Departmental growth, however, in this current budgetary climate, the additional degree program may prove to be too resource intensive. If so, it may be possible, as an intermediate step, to offer a 3+2
program, where the additional two years may be completed at a university with an existing, accredited EE program.

Class Sizes and Quality of Teaching: The physics curriculum as taught at CSUEB is rigorous for both the B.A. and B.S. programs. Class sizes for upper-division electives are small, necessitating classes offered only every other year. Class sizes for the lower-division introductory sequence are extremely high, necessitating the use of computerized homework grading and tutorials that are now commonly provided by the major textbook publishers. It is not unusual that the Department uses this model for homework grading, due to the very large class sizes and heavy teaching load. Despite these burdens, the Department is to be commended for trying its best to implement the best pedagogical methods currently practiced in such large classes, including both peer instruction and Think-Pair-Share.

The service load has increased in recent years due to the requirements of other departments. This has led to increases in lower division laboratory enrollments, which are at the room limits at 24, and for which at least 10 sections are offered each quarter. It is gratifying to see the support from the Dean for the new laboratory equipment for these heavily subscribed classes.

The rapidly growing enrollments in physics classes and laboratories (up by 125% in the past five years) has created a very difficult situation for the Department. At least one new hire in experimental physics is essential to maintain the quality of instruction in core physics courses as well as providing essential research opportunities in physics for undergraduates. At least one new tenure-track hire is my number two priority recommendation.

Elements of the program that are distinctive and unique include:

a) A state-of-the-art, nationally recognized atomic, molecular, and optical physics research program supported by nearly $600K in recent external grant funding
b) Externally funded STEM teacher education program
c) The recently acquired NSF MRI-funded $400K femtosecond optical frequency comb and THz spectrometer for atomic, molecular, and condensed matter spectroscopy
d) Early stage research in the development of new materials for solar cells

The research activities and abilities found in the Physics Department are strong, and are concentrated in Atomic and Condensed Matter Physics. Of course there is a variety of productivity from one member to another but the culture of significant and meaningful research with the students is established and increasing. The external support brought in is excellent for supporting undergraduate research. While the absolute numbers are important, it is equally noteworthy to see that there are student authors included and some as first author, many involve work from collaborations (with primarily UC Berkeley faculty) which implies an even broader range of experience for the students. These research accomplishments are all the more impressive when one considers that these
faculty have a heavy teaching load and much of the work involves undergraduate students.

**Scholarly work with undergraduate students, year-round, should be recognized for the prestige it brings CSUEB, for the example it sets, and for the many positive educational impacts it has on the students. I recommend that to facilitate and expand these efforts in the Physics Department, workload credit be given to scholarly work with undergraduate students. At least 1/3 WTU credit (CS 36) for each supervised research student is my number one priority recommendation.**

**Breadth of curriculum offerings:** An innovative element of education at CSUEB is the “cluster” sequence of courses for beginning students. The Physics Department is an enthusiastic participant in offering classes within this format, having offered one major and three non-major clusters in the past three years. The Department is also experimenting with offering some high-enrollment GE courses online, such as Biophysics, and potentially Astronomy. This is to be commended, and will ease the demand on facilities as well as schedule.

I note that this is a Physics department, not a combined Physics & Astronomy Department, and as such, the limited offerings in Astronomy are entirely appropriate. I listened with interest to ideas about obtaining a medium-sized telescope to support student research. However the Department has thus far chosen to specialize in Atomic and Condensed Matter physics, plus Physics Education, and is doing a great job obtaining the resources needed to support these areas. It would take considerable additional resources to build up another area of Departmental excellence in Astronomy, including several new courses, expensive equipment, and additional technician support. I therefore do not recommend that the Department undertake this type of effort without a serious consideration of available resources and commitment.

One element of concern that surfaced – I could not easily distinguish between the content and learning outcomes for the algebra/trig labs vs. the calculus-based labs. I urge the Department to rethink the skills involved in these two different classes, to ensure that the experiments are modified appropriately for the service lab sequence, even if, by necessity, the equipment is shared with the majors lab sequence. New labs for the algebra-trig sequence that could be considered might include some which have biomedical applications (e.g. gel electrophoresis) as a focus, to appear to the pre-health professions students who tend to predominate in these classes.

*The Department should carefully consider the resources needed before adding a robust Astronomy program to its areas of specialization. New biomedically-oriented labs for the algebra-trig sequence should be considered, in order to differentiate these labs from those intended for majors.*

*I also encourage the Department to consider offering a weekly colloquium series, as a course for credit (1 WTU and 1 SCU), in order to create a more distinctive identity for*
the Department, to encourage interactions with the donating public, and to help establish contacts with local industry.

**Preparation for employment in the discipline:** Due to the lack of a required capstone experience, it appears as though many of the physics majors gain their key laboratory skills through the upper division laboratory courses (3281 and 3283). There are also opportunities to gain key skills in computer programming and electronics, through additional required courses. Employable physics bachelors’ degree recipients need multiple opportunities to demonstrate a wide variety of technical skills.

*I urge the Department to carefully consider which skills are important for the students at each stage as they progress through the degree programs, and to devise a plan to ensure that all students have the opportunity to develop important technical skills in optics, electronics, computer programming, problem solving, instrumentation interfacing and troubleshooting. I also encourage the inclusion of other skills, such as numerical modeling, data reduction and/or image analysis in this analysis.*

**Teacher preparation in the field:** Students who are interested in pursuing secondary teaching credentials can pursue the Physics Education track within the B.A. degree. The Department has a very strong program in teacher education, in conjunction with other science Departments within the School, augmented by several notable externally funded programs, including the East Bay Science Project, the Math and Science Teacher Initiative, and participation in programs such as Project STAR (Science Teachers as Researchers) and the development of the physics curriculum needed to support the Transfer Project for Future Math and Science Teachers and the Foundational Level General Science Certificate program.

*Due to the looming shortage of (especially) high-school physics teachers, and the Department’s impressive efforts in supporting teacher education, I suggest that the Department consider joining PTEC (the Physics Teachers Education Coalition, http://www.phystec.org/). PTEC membership will raise the Department’s national visibility in this important area.*

**Laboratory Courses:** I toured the lower and upper division laboratories, and examined the Fall 2010 laboratory manuals for 2701 and 2703. The experiments are fairly standard, and the manuals were well written and very clear. I also reviewed the list of experiments used in 3281/3283.

Computers used in one of the lower division labs appear to have been recently replaced—however, I also read reports that they are 8-10 years old. The equipment and computers for the upper division labs did not appear to be current. Upper division students do have access to LabView and Mathematica, software packages which are in widespread use in other institutions, and industrial applications.

*Equipment for the upper division labs is dated and rather inadequate, and this may also be true for the computers in the lower division labs. I recommend that additional stations
and equipment be acquired for the upper division lab and that the experiments be redesigned to incorporate new equipment and modern pedagogy. I also recommend that this lab incorporate the new equipment that has recently been acquired in the research laboratories, in order to offer a wider range of hands-on inquiry based experiences, possibly including biophysics, or other subfields of applied physics. Since completely overhauling the upper division lab curriculum is a very expensive and time consuming process, I recommend incremental improvements as time and resources permit.

Faculty Preparation:

Appendix A of the Department’s self-study report includes the Faculty Vitae. It is clear from the various CVs that the tenured, tenure-track and adjunct faculty are certainly well prepared in their field. All have Ph.D.s and all the degrees are from respected schools and programs (including UCLA, UC Berkeley, UC San Diego, UC Davis). In addition, it was clear during informal dinner conversations that the faculty are knowledgeable about a range of current physics topics both in and outside of their particular areas of expertise.

While the faculty are clearly prepared in their sub-fields of physics, it is much more difficult to gauge their expertise in teaching. The opinions given here are based on observation and anecdote since I do not have access to any student evaluation data. All the undergraduates to whom I spoke about teaching during the visit were very positive about their interactions with the faculty. Faculty were uniformly praised for various talents and at no time during the visit did any student or faculty member express any dissatisfaction with the quality of instruction. The adjunct faculty expressed a desire to teach upper division courses on occasion, but realized that the tenure-track faculty have first choice. All tenure-track faculty appear to teach at least one large undergraduate lecture course, as well as various laboratory courses, and upper division courses.

Resources:
I have reviewed the summary of the Department’s grant activity provided in the self-study report, and provided in the Faculty CVs. I have also reviewed the Department staffing allocation, which currently consists of a full-time administrative assistant in the Department office, who also supports the pre-health professions students, and a full-time Laboratory Support Technician, who also helps repair equipment for the chemistry and engineering departments.

Considering the budgetary problems currently faced by the state of California and the CSU system, I find that the staff resources are adequate at the present time. However, supporting the research laboratories will increase the demands on the technician, especially as these relatively new facilities begin to age. Coupled with the growth of the service laboratory classes, additional technician support will be needed in future years, and should be considered as a potential use of future funding tied to FTES growth.

The physical resources occupied by the Department are not really adequate in several important areas: 1) The lower division lab rooms are shared by courses with different equipment needs, often necessitating the breakdown and re-setup of experiments several
times during a week. This adds additional workload to the very busy departmental technician. I understand the Department previously had two additional lab spaces, which have been transferred to Engineering. 2) The office space for faculty is lacking – faculty do not have private offices in which to meet with students. In one case a lecturer is sharing an office with two tenure-track faculty, which is not a typical situation. On the other hand, the research laboratory spaces for the newly obtained equipment, although spread out between two adjacent buildings, seem adequate for the size of the Department and the number of students involved in undergraduate research.

*I recommend that when minor capital outlay funds are again available, office space arrangements should be seriously reconsidered, to ensure that no more than two faculty share an office space. And the design of the potential new science building should take into account space for research, lower division laboratories, as well as adequate office space.*

As a potential new source of funding, the Department might consider keeping in touch with alumni by sending them a newsletter, inviting contributions to Departmental funds (e.g., laboratory equipment, student research stipends). It can be electronic, with news about the Department, highlighting faculty and student accomplishments.

**Outcomes assessment:**

The self-study report provides a list of learning objectives for physics students in the Introductory (2700) course sequence. In addition, Appendix C reports the results for the same pre- and post-test given to the Introductory and General (1000) physics students, which implies that the learning objectives are similar for the two populations. Some more general learning objectives are listed for the General physics courses. However, the objectives listed for first year sequences are not adequate for the graduating majors, who take many more courses than just the General sequence. Therefore, the Department may wish to revise its expectations for the majors in the context of the complete degree program.

*The Department should revisit their overall learning objectives, and consider modifying or adding learning objectives for physics graduates such as:*

1) *Students should know how to use the principles of physics*
2) *Students should be able to use reasoning and logic to define a problem in terms of principles of physics*
3) *Students should be able to use mathematics and computer applications to solve physics problems*
4) *Students should be able to design and/or conduct experiments and/or observations using principles of physics and instrumentation*
5) *Students should be able to properly analyze and interpret data and experimental uncertainty in order to make meaningful comparisons between experimental measurements or observation and theory.*
I was pleased to see that the Department takes assessment seriously, and has compiled several years of data, at least for the beginning course sequences. The use of a capstone course to do overall assessment for majors should be considered, as well as the use of the Major Field Test in Physics. The GRE in Physics is not applicable to those students who are not bound for graduate school, and the low number of these students will prevent meaningful data from being acquired.

Conclusion:

CSU EB’s Department of Physics is to be commended for providing engaging student-centered teaching and learning, to increasing numbers of students, despite strict financial constraints. My comments in this report are offered as helpful suggestions for improving what is already a solid undergraduate program, with distinctive elements that have the potential for national recognition.
Appendix – Additional Data that should be collected for future Program Review Self Studies

1) Student evaluation data – departmental averages and results for individual courses
2) Academic program data – list of all courses offered each semester and enrollments in each course. Track these data for several years
3) Capstone projects – list titles, assessment outcomes, advisors
4) Tracking information for career outcomes of graduated students. How many teach at the high school, college and university level? How many have gone to graduate school and successfully completed advanced degrees? In what fields?
5) List of square footage of rooms and total hourly usage rate with accommodations made for space required for storage, research and demos, major equipment, value, maintenance and future expansion. These needs then become justifications for the Dean and Provost, especially if they are not familiar with the needs of a lab based science program.
6) More information about the equipment used in teaching laboratories and computer availability in the Department, including the approximate age of the equipment and computers.
7) Degree program requirements for all degrees offered. (This material is online but should be included in the self-study report for completeness, along with statistics on how many students choose which degree option.)
8) Library holdings and access to physics journals.
4. Program Response to Outside Reviewer’s Report

On April 8, 2011 Dr. Lynn Cominsky, Chair of the Department of Physics and Astronomy at Sonoma State University, visited our department. Dr. Cominsky toured the facilities and met with all of the staff, tenure-track faculty, and most of the part-time lecturers in the department. She also had an opportunity to visit with current physics majors without faculty present in addition to meeting with Dean Leung. Dr. Cominsky’s report on the department is very positive. She comments that she is “impressed by the dedication of the faculty and staff to the well-being and achievement of the students” and that the department “is to be commended for providing engaging student-centered teaching and learning, to increasing the number of students, despite financial constraints.” She concludes her report by recognizing that the department “is already a solid undergraduate program, with distinctive elements that have potential for national recognition.” The department enthusiastically supports most of her suggestions, and has revised our five-year plan to explicitly include some of these. Below we summarize her key recommendations and respond to each in turn.

1) Scholarly work with undergraduate students, year-round, should be recognized for the prestige it brings CSUEB, for the example it sets, and for the many positive educational impacts it has on the students. I recommend that to facilitate and expand these efforts in the Physics Department, workload credit be given to scholarly work with undergraduate students. At least 1/3 WTU credit (CS 36) for each supervised research student is my number one priority recommendation.

   - We strongly agree with this recommendation. Other departments within the College of Science are able to compensate faculty for the out of classroom work they do with students, as well as other physics departments within the CSU. We will work with the Dean to implement such a policy.

2) The rapidly growing enrollments in physics classes and laboratories has created a very difficult situation for the Department (up by 125% in the past five years). At least one new hire in experimental physics is essential to maintain the quality of instruction in core physics courses as well as providing essential research opportunities in physics for undergraduates. At least one new tenure-track hire is my number two priority recommendation.

   - We have a submitted a tenure track request this year, a copy of which can be found in the appendix to this report. The position request was ranked favorably by Dean Leung, and we await a funding decision by the Provost.

3) Equipment for the upper division labs is dated and rather inadequate, and this may also be true for the computers in the lower division labs. I recommend that additional stations and equipment be acquired for the upper division lab and that the experiments be redesigned to incorporate new equipment and modern pedagogy. I also recommend that this lab incorporate the new equipment that has recently been acquired in the research laboratories, in order to offer a wider range of hands-on inquiry based experiences, possibly including biophysics, or other subfields of applied physics. Since completely overhauling the upper division lab curriculum is a very expensive and time
consuming process, I recommend incremental improvements as time and resources permit.

- Updating the equipment in our upper division laboratories has been and continues to be a priority for the department. In the past five years faculty from the department have applied for two external equipment grants for these labs. Unfortunately these were not accepted. In the current academic year the department applied for funds for the upper division lab in three different proposals under the Provost’s Instruction and Research Equipment Request grants. One of these was accepted, which will allow students to do cutting edge optics and material science experiments. Perhaps more significantly, two proposals to overhaul our lower division laboratories were accepted. These should allow the department to focus its modest budget on the upper division labs in the next few years. Finally it is worth noting that if the Academic Quality student fee (A2E2) recently proposed gets approved, there may be significant opportunities to upgrade these labs in the near future.

4) Considering the budgetary problems currently faced by the state of California and the CSU system, I find that the staff resources are adequate at the present time. However, supporting the research laboratories will increase the demands on the technician, especially as these relatively new facilities begin to age. Coupled with the growth of the service laboratory classes, additional technician support will be needed in future years, and should be considered as a potential use of future funding tied to FTES growth.

- The physics department currently has one full-time technician. His primary responsibilities are setting up lower division laboratories each week, repairing, maintaining, and replacing broken equipment, building and setting up classroom demonstrations, and assisting faculty in the upper division laboratories. While these tasks easily merit a full time position, our technician also works in several other departments. Primarily he assists in setting up equipment in the engineering department. When that department was started a decade ago it was agreed that he would assist them until a full-time technician could be hired. Incredibly, after more than 10 years the engineering department still does not have its own technician. This problem has been exasperated by recent budget cuts to the college. At least one technician in another department has recently retired, without being replaced. The physics department technician has tried to assist this department when he can. Finally, it is worth mentioning that with clear trend of growth in service courses with lab components, there will be a pressing need to hire additional support staff in the next few years.

5) I recommend that when minor capital outlay funds are again available, office space arrangements should be seriously reconsidered, to ensure that no more than two faculty share an office space. And the design of the potential new science building should take into account space for research, lower division laboratories, as well as adequate office space.

- We whole heartedly agree. A few years ago a report by the academic senate demonstrated that college of science faculty were disproportionately impacted by the lack of office space on campus.
6) In order to attract more majors, the Department might want to consider adding an algebra-trig B.A. program, designed to work as a double major with other disciplines, and with significantly fewer required upper division theory classes than the current B.A. degree.

- In this recommendation, the department respectfully disagrees with the reviewer. All of our major level courses require at a minimum a firm grasp of introductory calculus. Many also require more advanced mathematics like differential equations and linear algebra. We believe these prerequisites are reasonable, given the heavy use of mathematics in physics. Therefore, an algebra-based major would not be possible since no upper division majors courses exist for these students. It should be noted however, that in the last five years the department has simplified its minor to make it more accessible to students in other majors.

7) The Department should carefully consider the resources required by the addition of an Engineering Physics degree. This is a promising area for Departmental growth, however, in this current budgetary climate, the additional degree program may prove to be too resource intensive. If so, it may be possible, as an intermediate step, to offer a 3+2 program, where the additional two years may be completed at a university with an existing, accredited EE program.

- We completely agree with the reviewer on this point. An Engineering Physics degree would be an excellent way to bolster enrollment in our upper division physics classes, while also enhancing the fledgling undergraduate engineering opportunities on campus. Nevertheless, we are very aware that starting a new academic program in the current budget climate will be extremely challenging. As outlined in our five year plan, we intend to carefully study this issue before proceeding, getting input from our colleagues in the Engineering Department, campus administrators, and an outside industry advisory group.

8) I encourage the Department to require the senior capstone course that has recently been added to the catalog, so that all students can be involved in a distinctive culminating experience. Many undergraduate students now do high-quality research projects, leading to presentations at conferences and publications in refereed journals. While research experience is ideal for students bound for graduate school, capstone experiences should also offer opportunities for design projects (for students with industry goals) and instructional design projects (for students who wish to teach).

- The format of the current capstone class, which was added since the last review, is a theoretical overview of the different areas of physics, with an emphasis on viewing the subject as one integrated body of work. The reviewer is correct that the majority of our students are already participating in a capstone like project outside of class. Formalizing this experience and requiring it of all majors it an interesting suggestion. The faculty will consider how to best do this and we have added it as part our five year plan.
9) Due to the looming shortage of (especially) high-school physics teachers, and the Department's impressive efforts in supporting teacher education, I suggest that the Department consider joining PTEC (the Physics Teachers Education Coalition, http://www.phystec.org/). PTEC membership will raise the Department's national visibility in this important area.
   - This has been done.

10) The Department should carefully consider the resources needed before adding a robust Astronomy program to its areas of specialization. New biomedically-oriented labs for the algebra-trig sequence should be considered, in order to differentiate these labs from those intended majors.
   - The department has no immediate plans to add an astronomy program to its areas of specialization. As outlined in our report, as well as our 2010 tenure track request, we would like our next faculty hire to specialize in atomic physics, in order to build on the strong research program we have developed over the last several years in this area. It is true that recently the faculty has discussed pursuing funding to build an observatory on campus. The primary function of this observatory would be to support our general education courses in astronomy and to use in public outreach. It could also be used to support undergraduate research projects. However, a fair point is whether or not the department currently has the expertise necessary to support the construction and maintenance of an observatory on campus. This is not entirely clear, and the department agrees that this issue must be answered before pursuing external funding.
   - Over the past two years significant revisions have been made to our introductory physics laboratories for the algebra based sequence. With 30 different labs, changes to the course require a significant amount of faculty time and money, neither of which are in abundant supply. Nevertheless, we intend to continue to make incremental changes to update these labs as resources allow. We will investigate bio-medically-oriented labs as we do so.

11) I also encourage the Department to consider offering a weekly colloquium series, as a course for credit (1 WTU and 1 SCU), in order to create a more distinctive identity for the Department, to encourage interactions with the donating public, and to help establish contacts with local industry.
   - This is an intriguing idea that we have added to our five year plan for further study. In the past the department has had a successful seminar series, but it has often lagged as faculty became too busy to arrange for speakers. Creating a class with WTU and SCU associated with it could potentially solve this problem and allow the department to reap the benefits of a successful seminar series.
12) I urge the Department to carefully consider which skills are important for the students at each stage as they progress through the degree programs, and to devise a plan to ensure that all students have the opportunity to develop important technical skills in optics, electronics, computer programming, problem solving, instrumentation interfacing and troubleshooting. I also encourage the inclusion of other skills, such as numerical modeling, data reduction and/or image analysis in this analysis. The Department should revisit their overall learning objectives, and consider modifying or adding learning objectives such as...

- The faculty have had many informal conversations about which skills and overall learning objectives are important for our students, and where they get these in our program. We agree with the reviewer that it would be useful to more formally elaborate these and to map the skills and learning objectives back to particular classes. We have added this task to our five year plan.
Appendix A - Faculty CV’s

Erik B. Helgren

Department of Physics
University of California East Bay
251 South Science
Hayward, California 94542

Work: (510) 885-4604
Fax: (510) 885-4803
Home: (925) 556-3368
erik.helgren@csueastbay.edu

Education:

University of California Los Angeles, Ph.D., Condensed Matter Physics 2002
Dissertation: “Electrodynamics of Coulomb Glasses” Advisor: Dr. George Gruner
University of California Los Angeles, M.S. in Physics 1999
University of California Los Angeles, cum Laude and departmental honors, B.S. in Physics, 1996

Teaching Experience

CSUEB Department of Physics, 2008 – present
• Physics 2701, 2702 & 2703 – Introduction to Physics Lecture and associated labs
• Physics 4001, 4002 & 4003 – Upper division Electricity and Magnetism
• Physics 3101 & 3102 – Upper division Analytical Mechanics
• Physics 2005 – Science of Energy
• Physics 4600 – Solid State Physics
• Physics 3281 & 3283 – Advanced Experimental Physics Lab Series
• Physics 4250 – Selected Topics
• Physics 4850 – Undergraduate Research

UC LEEDS program (Learning and Education for Educationally Disadvantaged Students) mentor 2005 & 2006

Instructor, Los Angeles Valley College, Electricity, Magnetism and Electrical Circuits, 2002

Teaching Assistant/Associate, UCLA Physics Department, 1998 – 2002
• Solid State Physics, Electricity and Magnetism
• Solid State Physics senior lab
• Developed a new Senior Lab, Spectroscopic Techniques

Professional Experience

Staff Research Associate, UC Berkeley, CA 2005 – 2008
• Assisted in designing new 2000 sq. ft. lab space and coordinated and supervised moving the research labs of Dr. Frances Hellman and Dr. Robert Dynes from the University of California at San Diego to the University of California at Berkeley

Post-doctoral Researcher, UC San Diego, CA 2003 – 2005
• Research on correlated electronic phenomena in magnetic semiconductors, magnetic thin films, magnetic multilayers and metal-insulator transitions

Engineer, Hughes Aircraft Co. / Raytheon, Defense Systems, El Segundo, CA 1997
• Systems Engineer in charge of the Land Warrior Project Interface Control Spec.
Previous and Current Research:

**Transport Properties of Polymer Photovoltaics Materials**  
2008 - present  
California State University East Bay

We study the materials used in polymer photovoltaic (PV) cells and focus on techniques to improve the efficiencies of the PV cells by altering the materials used. Using dielectrophoresis we attempt to orient carbon nanotubes embedded in the active region of a polymer PV device, and quantify any changes in the transport properties of oriented, spun-cast embedded nanowires polymer films. This will in effect provide a top-down method of combining the benefits of bulk heterojunctions with an oriented nanostructured framework.

**Modeling and Measurement of Metamaterial (i.e. Negative Index of Refraction) Structures**  
2008 - present  
California State University East Bay

For this project we are modeling the electrodynamical response, basically determining the reflection and transmission of electromagnetic waves at various frequencies, for a series of patterned apertures engineered onto a metallic sheet. Such periodic arrays, with the appropriate design pattern, can show non-intuitive optical properties, such as displaying a negative index of refraction. For this research project we are developing the capability to produce various periodic structure arrays and measure their electrodynamical response in the terahertz spectral range, in order to correlate the experimental results with the simulations.

**Spectroscopic & Thermodynamic Properties of Photovoltaic Quality Si**  
2006 – present  
UC Berkeley & LBNL  
Frances Hellman

We have developed novel nano-calorimeters which can be used to measure thermodynamic properties of nanometer thick thin films. I continue to collaborate on a project, which I conceived, utilizing these thin-film calorimeters. We are growing photovoltaic (PV) quality amorphous hydrogenated silicon using CVD methods and performing in-situ thermodynamic studies of the light-induced degradation, known as the Staebler-Wronskii effect.

**Magnetic Semiconductor and Oxide Films**  
2003 - 2009  
UCSD & UC Berkeley  
Frances Hellman, Robert Dynes

This research focused on studying the role of magnetic dopants in amorphous thin films. MBE co-deposited amorphous Gd-Si samples show a mixture of ferro- and antiferromagnetic behavior and extremely large negative magnetoresistance (MR). A strong dependence on screening was found for the onset temperature of the large MR so by incorporating Gd into amorphous Ge and diamond-like carbon matrices (using both MBE growth and DC and RF magnetron sputtering) band-gap tuning was utilized to increase the onset temperature for the large MR. Most recently, we have lithographically patterned gated structures incorporating the magnetic oxide Zn(Co,O) and have successfully tuned the ferromagnetic phase by applying a gate voltage. Also in studying transition metal dopants an intriguing quenching of the magnetic Mn moments has been observed.

**Terahertz Spectroscopy of Doped Si and Semiconductor Thin Films**  
1997 – 2003  
2000  
UCLA  
George Gruner, Peter Armitage, Martin Dressel

This research was performed at UCLA, and as a visiting research scientist at the University of Stuttgart. I utilized FTIR, RF and microwave techniques as well as specialized THz sources to study the dielectric properties of a wide range of materials, including doped crystalline Si and metallic doped amorphous Si. These techniques and especially the unique backward-wave oscillator sources that produce broadband, tunable THz radiation, allowed spectroscopic measurements in the quantum limit, $\hbar \omega > k_B T$, in order to study the role of electronic correlations and weak localization effects near the metal-insulator quantum phase transition. My research established that, in contrast to predictions and the parallel with Fermi Liquid theory, the lowest lying excitations of such systems in the insulating phase are strongly modified by electronic correlation effects.

Publications


15. Z. Boekelheide, E. Helgren, and F. Hellman “Spin-density wave in polycrystalline Cr films from infrared reflectivity” Physical Review B 76, 224429 (2007)


**Book Chapter**


**Invited Talks/Presentations**

“Magnetism and Optical Properties of Doped Semiconductors” California State University Sacramento Department of Physics Colloquium, Sacramento, California March 2009


“Magnetism and Optical Properties of Doped Semiconductors” California State University East Bay Physics Seminar invited speaker, Hayward, California February 2008

“Magnetic Semiconductors” UC Berkeley Department of Physics Condensed Matter Quantum Materials Seminar invited speaker, Berkeley, California November 2007

“XAS on the Rare-Earth Doped Magnetic Semiconductor a-GdSi” Lawrence Berkeley National Laboratory Advanced Light Source User’s Meeting invited speaker, Workshop on Advanced Magnetic Spectroscopy, October 2006


“The Metal Insulator Quantum Phase Transition” UC Davis Condensed Matter Seminar invited speaker, Davis, California June 2006

“Universal and Non-Universal Behavior at the Metal Insulator Transition” Baltimore, Maryland, APS March meeting 2006
“Disorder and the Metal Insulator Transition” Oregon State University Physics Colloquium invited speaker, Corvallis, Oregon, February 2006


“Concentration vs. Magnetic Field Tuned Scaling at the Quantum Phase Transition in a-Gd₅Si₁₋ₓ” 50th Annual MMM Conference San Jose, California, November 2005


“Scaling in Magnetically Doped Semiconductors”, Los Angeles, California, APS March meeting 2005


“Characteristic Thermal Energy Scale for Suppression of Conductivity in Magnetically doped Amorphous Semiconductors”, Montreal, Canada APS March meeting 2004

“Electrodynamics of Coulomb Glasses; Disordered Insulating Systems near the Metal-Insulator Transition”, UCSD invited speaker, Condensed Matter seminar, May 2003

“Quasi-Optical Terahertz Spectroscopy” Rockwell Scientific Co. Invited speaker, Thousand Oaks, California, August 2002


“Frequency Dependent Variable Range Hopping in Fermi Glasses and Coulomb Glasses” University of Stuttgart, Vaihingen, Germany; Condensed Matter Physics Department, June 2001

Memberships and Service

Session Chair – Metal Insulator Transitions APS March Meeting
Physical Review Letters referee
Physical Review B referee
Journal of Applied Physics referee
Preparing Future Physics Faculty workgroup UCSD 2003
Graduate Recruitment Committee, UCLA Physics Department, 2002
2001-2002 Physics and Astronomy Alumni Alliance Award for Outstanding Graduate Student
1996 Dean’s Research Award Summer Stipend
California Faculty Association
DEREK F. JACKSON KIMBALL
derek.jacksonkimball@csueastbay.edu
1404 Dawn Court San Ramon, CA 94583
Work: 510-885-4634
Home: 925-309-4768

| PROFESSIONAL EXPERIENCE | September 2010-present | Associate Professor,
| | | California State University, East Bay
| | September 2005-September 2010 | Assistant Professor,
| | | California State University, East Bay
| | May 2005 - August 2005 | Postdoctoral Researcher,
| | | University of California at Berkeley

| EDUCATION | May 2005 | Doctor of Philosophy in Physics,
| | | University of California at Berkeley
| | May 2002 | Master’s Degree in Physics,
| | | University of California at Berkeley
| | May 1998 | Bachelor’s Degree in Physics and Mathematics
| | | (Highest honors in Physics),
| | | University of California at Berkeley

| AWARDS | 2002-2003 Outstanding Graduate Student Instructor Award
| | 1998 University of California Departmental Citation in Physics
| | (Awarded to the top student in the Physics Department graduating class)
| | Phi Beta Kappa (University of California at Berkeley, 1998)
| | National Merit Scholar (1994)

| GRANTS FUNDED | RUI: Search for a spin-gravity coupling using laser-addressed atomic gyroscopes, National Science Foundation ($254,150.00 over 3 years, 2007-10).
| | Major Research Instrumentation, Recovery and Re-investment: Acquisition of a Femtosecond Optical Frequency Comb and THz Spectrometer for Atomic, Molecular and Condensed Matter Spectroscopy, National Science Foundation ($393,388.00 over 1 year, 2010-2011).
| | RUI: Search for Anomalous Proton Spin Interactions with A Dual-Isotope Rubidium Magnetometer, National Science Foundation ($309,514.00 over 3 years, 2010-13)

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RECENT COLLABORATORS
- Prof. Dmitry Budker, Department of Physics, UC Berkeley (Advisor)
- Prof. David P. DeMille, Department of Physics, Yale University
- Prof. Michael Romalis, Princeton University
- Prof. Jason Stalnaker, Oberlin College
- Academician Evgeniy B. Alexandrov, Vavilov State Optical Institute, Russia
- Dr. Max Zolotorev, Lawrence Berkeley National Laboratory
- Prof. Sadiq Rangwala, Raman Research Institute, India
- Prof. Wojciech Gawlik, Jagiellonian University, Poland
- Prof. Marcis Auzinsh, University of Latvia, Latvia

PROFESSIONAL SERVICE
- Member of National Science Foundation grant review panels.

PUBLICATIONS

Books


Articles


E. B. Alexandrov, M. Auzinsh, D. Budker, D. F. Kimball, S. M. Rochester, and


**TALKS**


“Investigation of collisional properties of atomic ytterbium, relevant to a vapor cell parity violation experiment,” at *Violations of Fundamental Symmetries in Atoms and Nuclei*, Institute of Nuclear Theory, University of Washington (Seattle), July 6-10, 1999.


“Progress toward Fundamental Symmetry Tests using Nonlinear Faraday Rotation,” at *ComminsFest Symposium*, University of California (Berkeley), May 21, 2001.


“Progress in Atomic Magnetometry” at *Atomic Physics Colloquium*, Jagiellonian University (Krakow, Poland), June 14, 2004.


“Applying electric fields to antirelaxation-coated cells and a proposal to search for a gravitational dipole moment” at Office of Naval Research MURI Meeting on Magnetic Detection Science and Technology, (Panama City, Florida), June 9, 2006.

“Gravitational Dipole Moments of Elementary Particles and the Matter/Antimatter Asymmetry of the Universe” at Theoretical Physics Seminar, Raman Research Institute (Bangalore, India), August 14, 2006.

“A New Search for an Atomic Gravitational Dipole Moment” at Institute Colloquium, Raman Research Institute (Bangalore, India), August 17, 2006.

“A New Search for an Atomic Gravitational Dipole Moment” at Atomic Physics Seminar, University of California (Berkeley), September 13, 2006.

“New search for a spin-gravity interaction” at the Meeting of the American Physical Society (APS) Division of Atomic, Molecular & Optical Physics, Calgary, Alberta, Canada, June 6, 2007.


“New search for a spin-gravity interaction” at the California Meeting of the American Physical Society (APS), Berkeley, California, October 27, 2007.

“The Advanced Laboratory Program at California State University – East Bay” at the Topical Conference on Advanced Laboratories at the American Association of Physics Teachers Meeting, Ann Arbor, Michigan, July 23, 2009.

“Testing the Laws of Physics with Atomic Spectroscopy” at the Physics Department Colloquium at San Jose State University, San Jose, California, February 11, 2010.

CLASSES TAUGHT
- Physics 1001: General Physics I (Calculus-based)
- Physics 1002: General Physics II (Calculus-based)
- Physics 1003: General Physics III (Calculus-based)
- Physics 1001 Laboratory: General Physics
- Physics 1002 Laboratory: General Physics
- Physics 1003 Laboratory: General Physics
- Physics 2701 Laboratory: Force/Mass/Motion
- Physics 2703 Laboratory: Light/Modern Physics
- Physics 3151: Thermal Physics I
- Physics 3152: Thermal Physics II
- Physics 3180: Computational Physics
- Physics 3280: Electronics
- Physics 3281: Experimental Physics
· Physics 3283: Advanced Laboratory
· Physics 3301: Quantum Mechanics I
· Physics 3302: Quantum Mechanics II
· Physics 3303: Quantum Mechanics III
· Physics 4001: Electromagnetism I
· Physics 4250: Atomic Physics
· Physics 4250: Great Experiments
· Physics 4250: The Big Bang
· Physics 4250: Optical Frequency Combs
· Physics 4700: Modern Optics
· Physics 4850: Physics Capstone
Professional Experience

2009 – present  Associate Professor  Department of Physics, California State University, East Bay
2008 – 2010  Director  Transfer Project for Future Science Teachers California State University, East Bay
2006 – present  Department Chair  Department of Physics, California State University, East Bay
2006 – present  Co-Director  Math and Science Teacher Initiative, California State University, East Bay
2003 – 2009  Assistant Professor  Department of Physics, California State University, East Bay
2002 – 2003  Postdoctoral Researcher  Advanced Light Source Division, Lawrence Berkeley National Laboratory

Education

Ph.D.  Physics  University of California, San Diego (2002)
B.S.  Physics  San Diego State University (1995)

Professional Achievement

Physics Research

Current research is centered on infrared spectroscopy of novel electronic and magnetic condensed matter systems. Key results from my work include:

- Discovery of the pseudogap state in electron doped high temperature superconductors.
- Spectroscopic investigation of characteristic energy scales in High-Tc superconductors.
- Observation of strong coupling effects in the heavy fermion superconductor CeCoIn5.
- Determination of the electronic structure of the magnetic semiconductor Ga1-xMnxAs.
- Investigation of charge dynamics in half-metallic ferromagnets.
- Doping and temperature dependent electron paramagnetic resonance studies of the colossal magnetoresistance compound La1-xCaxMnO3+y.
- Investigated applications of sub-THz synchrotron based sources in condensed matter.
Education

• Directed a project to increase transfer of students interested in becoming math and science teachers from community colleges to the CSU that involved 11 institutions and 65 faculty and administrators.

• As Co-Director of the campus’s Math and Science Teacher Initiative I developed a new undergraduate credential pathway for math and science majors, expanded our outreach activities to undergraduates, and initiated the “Affiliates” tutoring program where both CSU and regional community college lower division math and science students tutor in local K-12 math and science classrooms.

• I am a member of the board of directors, and a frequent contributor to the East Bay Science Project. This is a group of professional scientist working to improve science literacy in California elementary and secondary school educators.

• Served as a faculty liaison at Lawrence Livermore National Laboratory for the Science Teacher as Research (STAR) program. Supervised 10-15 future and early career science teachers doing internships at the lab and ran weekly science education workshops.

• I have taught eighteen different University physics courses at all undergraduate levels. My teaching is highly praised by students during anonymous course evaluations.

Grants Received

2010 Math and Science Teacher Initiative – CSU Chancellor’s Office; $135,000
2010 Acquisition of a Femtosecond Optical Frequency Comb and THz Spectrometer for Atomic, Molecular, and Condensed Matter Spectroscopy - NSF; $393,000
2009 Math and Science Teacher Initiative – CSU Chancellor’s Office; $125,000
2008 A Model Community College Transfer Program for Future Mathematics and Science Teachers - S. D. Bechtel Jr. Foundation; $280,000
2008 Math and Science Teacher Initiative – CSU Chancellor’s Office; $150,000
2007 Math and Science Teacher Initiative – CSU Chancellor’s Office; $150,000
2007 Investigating Alternative Energy Resources – CSUEB Faculty Support Grant; $5,000
2006 Math and Science Teacher Initiative – CSU Chancellor’s Office; $50,000
2005 Exploring the Phase Diagram of Na$_2$CoO$_2$ – CSUEB Faculty Support Grant; $5,000
2004 An Infrared Study of Heavy Fermion Systems – CSUEB Faculty Support Grant; $5,000

University Service

2010 - present CSUEB Academic Senate
2009 – 2010 University Committee on Layoffs
2007 – 2009 CSUEB Faculty Hearing Panel
2007 - 2009 Coordinator of Science Single Subject Matter Preparation Program
2007 – 2008 Chair, Physics Department Committee on Tenure Track hiring
2006 – 2008 University Committee on Academic Planning and Review
2006 – present CSUEB Council on Teacher Education
2006 – present Early Assessment Program Advisory Board
2006 – present College of Science Curriculum Committee
2006 - present Department of Physics Undergraduate Advisor
2006 – 2008 College of Science Scholarship Committee
2005 – 2008 Basic Skills Requirement Appeals Subcommittee
2004 – 2006 CSUEB Academic Senate
2004 – 2005 Physics Department Committee on Tenure Track hiring
2003 – 2008 College of Science Radiation Safety Committee
Classes Taught

PHYS 1600  Evolution of the Universe
PHYS 1800  Astronomy
PHYS 1880  Astronomy Laboratory
PHYS 2701  Force/Mass/Motion, Lecture and Laboratory
PHYS 2702  Heat/Sound/Electricity, Lecture and Laboratory
PHYS 2703  Light/Modern Physics, Lecture and Laboratory
PHYS 3101  Analytical Mechanics I
PHYS 3102  Analytical Mechanics II
PHYS 3150  Thermal Physics
PHYS 3281  Experimental Physics
PHYS 3283  Advanced Laboratory
PHYS 3301  Quantum Mechanics I
PHYS 3302  Quantum Mechanics II
PHYS 3800  Achievements of Women in Science
PHYS 3875  Math Physics, Laboratory
PHYS 4250  Superconductivity Seminar, Cosmology Seminar
PHYS 4600  Solid State Physics
PHYS 4950  Physics Capstone

Publications

B. C. Chapler, S. Mack, R. C. Myers, A. Frenzel, B. C. Pursley, K. S. Burch,


EDUCATION

Ph. D., Materials Science and Engineering, University of California, Davis. March 2006.

Bachelors of Science, Physics, California Polytechnic State University, San Luis Obispo, September 1999.

AREAS OF SPECIALIZATION

Areas of advanced studies include irradiation induced defects in ceramics and materials characterization including transmission and scanning electron microscopy as well as nanotechnology and science education for both formal and informal education institutions.

RESEARCH EXPERIENCE

Graduate Student Researcher, University of California, Davis, 7/00-6/05
Performed research in multiple areas of Materials Science under the direction of Dr. Joanna Groza. Served as the laboratory safety coordinator 2002-2005 which duties included safety training, chemical inventory, and hazardous waste management. Created and maintained research group website. Trained in x-ray diffraction, scanning electron microscopy, atomic force microscopy, and optical microscopy. Extensive training in transmission electron microscopy including high resolution, in-situ, g • b analysis and Lorentz microscopy to study magnetic domains.

Research Assistant, Cal Poly State University, San Luis Obispo, Summer 1999
Conducted research on stochastic resonance, a field of nonlinear dynamics. Used extended nonlinear optical systems as a way of studying the behavior of arrays of coupled nonlinear bistable elements or oscillators in two dimensions. Responsibilities included creating programs in Matlab and LabVIEW to model and analyze stochastic systems as well as setting up and testing optical equipment. Experience acquiring and analyzing data using LabVIEW, Maple, Matlab, Mathematica, Differential Systems, Data Logger, Mac Motion, and C++ as well as multiple spreadsheets and graphing programs.

TEACHING EXPERIENCE
**Lecturer**, Department of Physics, California State University East Bay, 04/07-present
Teach introductory algebra and calculus based physics courses and labs for science majors requiring a good foundation in physics as well as conceptual physics courses for non-science majors. Lectures taught include PHYS 1003, 1500, 1700, 2701, 2703, 3011 and 4250. Labs taught include PHYS 1001, 1002, 1003, 1780, 2701, 2702, 2703 and 3012.

**Part Time Faculty Instructor**, Physical Sciences, Mathematics and Engineering Division, Foothill College, 4/07-present.
Teach introductory calculus based physics courses and labs as well as a series of Nanotechnology courses. NANO 51, 52, and 53 provide an introduction to the fundamental science and technology of modern materials with particular emphasis placed on understanding the basic physics and chemistry of materials processes and material structures. Courses taught include PHYS 4A, ENG 45, NANO 50, NANO 51 and NANO 52. Currently developing NANO 53 and 54 with a grant provided by the National Science Foundation.

**Lecturer**, Department Chemical Engineering and Materials Science, San Jose State University, 08/09-present
Teach MATE 297: Applications of Nanomaterials. A graduate level course giving an advanced survey to different aspects of active research in nanotechnology, covering the broad area of thermodynamics, physics, chemistry, and material science.

**CSU Faculty Liaison**, STAR summer research internship at NASA Ames 04/09-present
Design and implement weekly seminars and workshops focused on science teaching for STAR, a summer research internship for aspiring science and mathematics teachers offered by the California State University in partnership with the US Department of Energy national research laboratories, NSF, NASA, federal agencies, and private research organizations.

**Science and Mathematics Teacher Education Program Coordinator**, College of Education & Allied Studies, California State University East Bay, 04/08-9/09
Coordinate the Bachelor’s Plus Early Pathways (BPEP) program, a math and science single subject teaching credential program at Cal State East Bay. Duties include recruiting students, coordinating the efforts of the program directors and leads, undergraduate student advising and community college liaison. Duties also include the development and implementation of an affiliate scholar tutoring program between CSUEB partner community colleges and local high schools.

**NISE-Net Project Coordinator**, Exploratorium, San Francisco, CA 1/07-7/07
Nanoscale Informal Science Education Network project coordinator. Helped develop and disseminate nanoscale science educational materials to core museums and partner institutions.

**Postdoctoral Fellow**, Exploratorium Teacher Institute, San Francisco, CA 6/05-
Developed hands-on inquiry based activities to teach scientific concepts and principles for formal and informal education institutions. Advised exhibit developers about scientific content, composed and edited text to accompany exhibitions, taught classes for teachers who use the exhibits and exhibitions at the museum, and created online learning materials for the museum website.

**Teaching Assistant**, Department of Chemical Engineering and Materials Science, University of California, Davis, 6/04-6/05
Taught the Properties of Materials Laboratory, Engineering 45L. Duties included giving lectures, monitoring laboratory sessions with the students, grading students work, and course curriculum development.

**Teaching Assistant**, Department of Chemical Engineering and Materials Science, University of California, Davis, Summer 2002 and Summer 2003
Teaching assistant for COSMOS, the California State Summer School in Mathematics and Science, a four-week program for talented and motivated high school students. Duties included designing and implementing laboratory experiments to introduce the students to subjects related to math and science that are not traditionally offered in high school.

**Teaching Assistant**, Department of Materials Engineering, Cal Poly State University, San Luis Obispo, Spring 2000
Taught the Materials Engineering Laboratory, Materials Engineering 215. A laboratory course designed to study the physical and mechanical properties of materials.

**Physics Studio Teaching Assistant**, Department of Physics, Cal Poly State University, 1998-2000
Conducted problem sessions and office hours for undergraduate physics courses. Constructed tests and quizzes, graded tests and homework and provided timely and lucid solution sets. Participated in numerous teaching workshops and seminars offered through Cal Poly.

PUBLICATIONS

*Materials Science and the Nanoworld* [http://www.exo.net/~jillj/](http://www.exo.net/~jillj/)

*Nanotechnology and Engineering at Foothill College* [http://fgamedia.org/faculty/rdcormia/NANO/](http://fgamedia.org/faculty/rdcormia/NANO/)


Johnsen, Jill. **Irradiation Induced Dislocations and Vacancy Generation in Single Crystal Yttria Stabilized Zirconia.** (Doctoral dissertation, University of California, Davis, 2006).

Xiao Chun Li, Jill Johnsen, Joanna Groza, and Fritz Prinz. **Processing and microstructures of fiber Bragg grating sensors embedded in stainless steel.**

ABSTRACTS AND PRESENTATIONS


Jill Johnsen. Nanotechnology and Green Energy. Guest Lecture, Osher Lifelong Learning Institute (OLLI), Concord, CA, November 18, 2009

Jill Johnsen and Dan Hernandez. Green Degrees. Presentation, CSU Counselors Conference Santa Clara, California, September 21, 2009

Jill Johnsen. Physical Science. Workshop, Bay Area Science Project (BASP), Albany Middle School, CA, June 23rd-25th, 2009

Jill Johnsen. Physical Science. Workshop, Bay Area Science Project (BASP), TASK Summer Institute, Albany Middle School, CA, August 10-13th, 2009


Jill Johnsen, Joanna Groza, and Fritz Prinz. **Layered Fabrication of Solid Oxide Fuel Cells.** Poster presentation TMS Annual Meeting & Exhibition, San Diego, California, March 2-6, 2003.


**GRANTS AND FELLOWSHIPS**

NSF Advanced Technological Education Grant (Curriculum Development with Foothill College, 2009), $500,000

**PROFESSIONAL AFFILIATIONS**

California Science Teachers Association (CSTA)
National Science Teachers Association (NSTA)
American Association of Physics Teachers (AAPT)
Materials Research Society (MRS)
Council of Math/Science Educators of San Mateo County (CMSESMC)
Centers for Learning and Teaching Network (CLTNet)
Nanoscale Informal Science Education Network (NISE Network)
The American Ceramic Society (ACerS)
ASM International
The Minerals Metals & Materials Society (TMS)
EDUCATION SUMMARY:

**Ph.D. PHYSICS**
- GPA 3.956  
- University of California, Davis
- June 1983

**DISSERTATION:** A Clifford Algebra Multivector Reformulation of Classical Field Theory  
A pedagogical work, reformulating classical and quantum physics with geometric algebra, yielding new interpretations and predictions.

**B.S. PHYSICS**
- GPA 3.906  
- University of California, Davis
- June 1975

  - Highest Honors
  - Physics Department Citation
  - June 1975
  - Honorable Mention
  - National Science Foundation
  - March 1975
  - Deans Honor List
  - All academic quarters 1971 -1975
  - Hertz Foundation Scholar
  - [Dr. Edward Teller, Director]
  - 1971 -1975
  - Honor Society
  - Phi Kappa Phi
  - March 1974
  - Kraft Scholarship Prize
  - For Outstanding Freshmen
  - June 1972
  - Alumni Scholar
  - UCD Cal Aggie Alumni Assoc.
  - June 1972

TEACHING EXPERIENCE:

**Santa Clara University**  
Physics Dept., Adjunct Faculty, Astrolab Coordinator  
General Astronomy, Ricard Observatory Consultant  
PreMed and Engineering Physics, Nuclear Quant Lab  
1993-2010

**Calif. State Univ. Hayward**  
Physics Dept., Musical Acoustics  
Astronomy Lecture & Lab, Conceptual Physics Lec/Lab  
1990, 94

**Las Positas College**  
Astronomy & Physics Lecture & Lab  
2006-2010

**Foothill College**  
Astronomy Lecture & Lab  
2008

**City College San Francisco**  
Astronomy, Physics & Mathematics  
2005-2008

**College of San Mateo**  
Computer Information Science Dept., Part Time Faculty  
Intro to Programming (Visual Basic, C++, Data Struct)  
1998-2004

**College of Marin**  
Physics Dept., Part-Time Faculty  
General Astronomy  
1992-94

**San Francisco State Univ.**  
Physics Dept., Part-Time Faculty,  
General/Pre-Med Physics, Astronomy, Electronics,  
Phys Lab & Dept. Colloquia Coordinator, 3 grad students  
1990-92

**Calif. State Univ. Sacramento**  
Physics Dept., Lecturer  
Astronomy Lecture & Observational Lab, Physics Labs  
1985-90

**Univ. of California, Davis,**  
Physics Dept., Lecturer  
General Astronomy & Astrophysics, Pre-Med Physics  
Astrophysics Lab Coordinator, Physics Lab Development  
1983-85

**Napa Valley College**  
Physical Science Dept., Part-Time Faculty  
Descriptive Introductory Astronomy  
1983-84

**UC Davis Extension**  
Enrichment programs for 4th-9th graders  
1981-84
RESEARCH ACTIVITIES:

Papers/Talks

Galileo & Einstein were wrong? Spinning balls fall slower? (CSUEB 2007)

Is $E=mc^2$ wrong, or is something missing? (SF City College, Nov 2005)

Spinning Particle Geo-Electro-Dynamics (Stefan Institute, Slovenia, 2005)

Teleparallel Treatment of the Ehrenfest, Sagnac and Field Rotation Paradoxes
21st Pacific Coast Gravity Meeting, (Univ of Oregon 2005)

Is Gauge Invariance Violated by Spin and Torsion?
20th Pacific Coast Gravity Meeting, (CalTech 2004)

If Particles Follow Autoparallels, Must Then EM Couple to Torsion?
19th Pacific Coast Gravity Meeting, (Univ of Utah 2003)

Classical Spin Electrodynamics in Background Curvature and Torsion
18th Pacific Coast Gravity Meeting, (UCDavis 2001)

Dimensionally Democratic Calculus and Principles of Polydimensional Physics
(Conference on Appl of Clifford Algebras in Physics, Mexico 1999)

Why Does Real Physics Need Imaginary Numbers?, San Jose State U (1999)

Classical Action Principle for Equations of Motion of Spinning Particles in Curved
Space (Midwest Relativity Conf, N. Dakota State U, 1998)

What is a Path for Creating New Theoretical physics, Santa Clara U, 1998?

Should Absolute Metric Signature Matter in Clifford Algebra Formulations of Physical

Clifford Algebra Derivation of the Characteristic Hypersurfaces of Maxwell's Equations
(conference proceedings, Univ of Lodz, Poland Sept. 1992)

Classification of Multivector Theories and the Modification of the Postulates of
Physics (conference proceedings, Univ of Gent, Belgium, May 1993)

Multivector Solutions to the Hyper-Holomorphic Massive Dirac Equation (conference
proceedings, Univ Arkansas April 1993)

A Clifford Dyadic Superfield from Bilateral Interactions of Geometric Multispin Dirac
Theory (conference proceedings, UNAM, Mexico, Sept 1993)

Invitations to Speak/Visit

Polish Academy of Sciences: Institute of Physics (1993)

Bach Center, Institute of Mathematics, Warsaw, Poland (1994)

International Society for Analysis its Applications and Computation (1997)

Cal State Pomona, led workshop on Clifford Algebras in Physics (Su 2000)

Jozef Stefan Institute, Ljubljana, Slovenija (Summer 2005)

University Trieste & Intern. Center for Theoretical Phys, Italy, Summer 2005

Referee:

Amer Jour. of Physics (93-94), Foundations of Physics (1991,92,97,00), Netherlands

OTHER EXPERIENCE:


San Mateo Group Inc. Director, Information Services (staff of 4 programmers) 1995-
Technical Analysis for venture capitalist group 2005

Lawrence Livermore Lab Nuclear Physics Division, 1975
Simulation of neutron damage & radiation thru matter

Crocker Nuclear Lab UC Davis (Cyclotron), AEC appointment 1974
Data reduction of polarized neutron beam experiment detector setup, n-line data acquisition and analysis

UCD Observatory Undergraduate Independent Research Project, 1972-75
Photometric Telescopic Measurement of Eclipsing Binary Star, data reduction, analysis, model fitting

State of California Information Services, Dept. of Food & Agriculture 1988-90
Environmental Hazards Scientist/Computer Specialist

UCD Counseling Center Peer Counselor, Supervisor at ”The House” program 1976-80
Academic & Crises Intervention
Supervision/training of student peer counselors
BUILDING A BETTER STUDENT

At 10-year mark, innovative learning communities register results

Editor's note: This is the first report in a year-long project in which Call Team East Bay magazine follows first-time freshmen in the University's Learning Communities. (Continued on page 10)

I'm the first day of the fall quarter. Physics class is packed with freshmen—not nearly as dice in sight. The classroom isn't yet bustling with chatter, since this group of about 20 first-year science students hasn't gotten to know the subject matter enough, or yet. They soon will.
Each student is enrolled in "Brain, Physics and the Mind," part of CSUH's innovative 10-year-old Learning Community program that has been cited as a national education model for producing students with stronger writing and critical thinking skills and for scoring more of them in standardized tests compared with other students graduating schools that don't offer such a program. Over the course of their freshman year, they'll see the same four classes each quarter, team up to study for final exams and finals, collaborate on bipartite research about neurological and humanities questions in tandem of sound and computer music together.

But that's all for now.

During the first September session of Physics 110, behind the desk, there's a student, as handsome William "It's Bill" Purpura broke the ice by asking: "How many people in the class are actually motorized?"

Almost all the students笑了 into the air.

"Now it's no sly statements, now many play instruments?" he asks.

"Half the class, I think," groans Mr. Tracy, one of the few students who can't stay about taking on expansions to the question for the last day.

After class, Allison was putting the finishing touches on the "Brain, Physics and the Mind" course because of its integration of music and physics. "I'm really into science," says Allison, who describes her love for understanding physics and plans to major in business. "Although I would be interesting."

Over the summer months, Cal State L.A.'s physics program will shadow Allison and her classmates as they work their way through the physics learning community program, which also includes a special studies skills component. The program at Cal State L.A. offers a form of learning community. Across the country, most learning community programs are tailored toward students who have basic skills needs.
Appendix B - Physics in the News articles

Modelling success

"Write the only note I know of a science class that is modelled all year long for all teachers," General Education Program Director Sally Murphy says. "It's been a remarkably successful program.

Murphy refers to it as modelled for "better learning.

Natalie studies being a Synapse University and the Emergent State College program that learning is a mindset, including CEU's help build better citizens. The program shows that students of CEU's programs that continue to use successful teaching methods that encourage students to interact and work together, taking basic skills courses to general education classes, providing academic support such as tutoring and peer tutoring and allowing them to acquire the skills. Most importantly, compared with students who don't participate in learning, non-university, "I still have a feeling for learning," General Education Program Director Sally Murphy says.

"That's one of the greatest ways to contribute to their overall success, by taking them on more comfortable in the classroom environment," Sally Murphy says. "It helps students feel more comfortable in the classroom environment, as the teacher helps them feel more comfortable in the classroom environment, as the teacher helps them feel more comfortable in the classroom environment."
A Sound Experiment

Twelve weeks into the quarter, he had already tried the physics 120 clocks into the group for weekly lab sessions in Science North 6D6. In the lab, students will take a brief quiz in the forming, then take exams on plasma and plasma influences in the lab. Each, and the last two make up the last two units of the class.

During the first lab meeting, instructor and student engineer Mike Nutzenberg showed up. He led a brief discussion on the nature of the ionization process in the lab. Thus says he used in the "Runway: Physics and the Mind," because he's already got a music-related institution to work with.

ON THE SAME WAVELENGTH

Lab sessions in "Runway: Physics and the Mind" focus on a single collaborative project.

For an O'Sullivan lab experience, a two-person team is typically assigned to a small, well-defined topic that is of interest to each student. The topic is typically an emerging topic, a current, interesting topic.

The team then develops a proposal for their project, including a clear description of the topic, a plan for the research, and a timeline for the completion of the project.

Altamont — in the fall of 2008, the lab team decided to develop a project focused on the history of the electric guitar. The team's proposal included a detailed discussion of the history of the electric guitar, including the development of the instrument and the role of the electric guitar in popular music.

IN YOUR FACE

I'm not sure what the significance is of the electric guitar and its role in popular music, but I'm thinking of it as a symbol of a new era, a new era of creativity and innovation.

A RIDE OFF

I love music with a purpose. It's a way to find a place in the world and to express ourselves. It's a way to connect with others and to share our experiences.

IN YOUR HEAD

It's hard to say what the significance is of the electric guitar and its role in popular music, but I'm thinking of it as a symbol of a new era, a new era of creativity and innovation.

IN YOUR HEART

I'm not sure what the significance is of the electric guitar and its role in popular music, but I'm thinking of it as a symbol of a new era, a new era of creativity and innovation.
A SENSE OF BELONGING

A couple months into her freshman year, Elizabeth is beginning to find a sense of community, with some of her fellow community college students and others who take a class to study on days she doesn’t have class.

In George’s words, who was once a sophomore, sometimes writes an email to the class, and the message is often centered around his love of the subject and his own experiences in the classroom. "I want to tell you that this is an amazing class, and I wish I was able to take it more often," he says.

As a member of the class, Elizabeth feels a sense of belonging, and she has a strong relationship with her classmates. "We all have a lot in common," she says. "We’re all here because we love physics and we’re excited to be here together."
It's very satisfying knowing that NASA and (the European Space Agency) could develop a model that would predict major debris trajectories based on data I helped take.

Rene Jacome
SENR, PHYSICS MAJOR

ACCIDENTAL ASTRONOMER

Kittling and Jacome were never the likely bonded team to talk it through on the Jules Verne.

After all, Kittling had never studied astrophysics, but instead history. But the 35-year-old needed help and so he turned to Kittling, who has developed an expertise in free-fall photography in his quest to chronicle extreme sports from the skies.

A few days later, Kittling's interest in space travel grew and he decided to give camera a whirl.

About a week before, Kittling had been entertained by images of meteors and asteroids, which are created by creatures on the outside of planets. This led him to purchase a camera for NASA, which has been gathering data for potentially harmless asteroids. The Jules Verne mission made it onto Kittling's radar, but he was nosy about astronomy. He wondered whether Kittling's camera might change his mind.

But the safety aspect of space travels the falling world is what led Kittling on the study mission. Since his first experience with Kittling in 2004, the astronaut has been on the lookout for extraterrestrial life. Other examples of his studies include taking pictures of celestial "sweater hitchers," from buses, helicopters, and planes. He also has a keen interest in the National Oceanic and Atmospheric Administration's Vela program.

In fall 2004, he and his students flew aboard the Jules Verne, which was designed to study new types of space missions.

But Kittling had plenty to do to occupy him while astro wresting, including field-testing a possible camera setup and taking field-of-view measurements. "The most important lesson here is that we need to know what our mission is and whether it can be done safely," he said.

In fact, a major challenge of the space program was ensuring the spacecraft would keep its bearings. Researchers spent hours mapping out the maneuvers, which were designed to maintain a steady course — not keep a steady course, but keep a steady orbit. "We need to keep in mind the technical issues with this particular mission," Kittling said.
Appendix B - Physics in the News articles

RETURN OF THE JULES VERNE

All the trials and tribulations that seem inevitable in the development of an ocean-drilling vessel like the Jules Verne are well worth enduring when the vessel is returned safely to its port of origin. The Jules Verne is a prime example of the kind of vessel that, with the right precautions, can be used to explore the deep ocean and gather valuable scientific data. The vessel is equipped with state-of-the-art technology, including advanced sensors and cameras, that allow scientists to conduct a wide range of oceanographic research. The Jules Verne has already completed several successful expeditions, and its return to port marks the beginning of a new chapter in its story. The vessel is expected to be ready for its next expedition within the next few months. Meanwhile, the crew is hard at work, preparing the vessel for its next adventure. The Jules Verne is a testament to the power of human ingenuity and the potential of ocean exploration. Its return to port is a reminder of the importance of perseverance and the value of scientific discovery. The Jules Verne is a symbol of hope and inspiration, and its story will continue to inspire generations to come.

One of Kitting’s cameras was fitted with a “sufficiently fast” shutter to capture the image of the two astrophysical phenomena—a rare event in the history of astrophysics. The shutter was opened for 50 milliseconds, allowing the two phenomena to be captured simultaneously. The result was a stunning image that captured the attention of the scientific community. The image showed the two phenomena side by side, providing a unique perspective on the nature of these cosmic events. The image was published in a prestigious scientific journal, and it generated considerable interest among astronomers and astrophysicists. The image was a testament to the power of modern technology in advancing our understanding of the universe. It was a reminder of the importance of collaboration and innovation in the pursuit of scientific discovery. The image was a symbol of hope and inspiration, and it will continue to be a source of wonder and fascination for years to come.

ACCOLADES FOR CAL STATE EAST BAY

Kitting and another team member are invited to be a part of the prestigious National Defense Foundation, which focuses on promoting the development of new technologies and strategies for national defense. The team has been recognized for their outstanding contributions to the field of astrophysics, and they are expected to play a significant role in the future of the National Defense Foundation. The team has already shown exceptional promise in the field of astrophysics, and they are expected to continue their success in the future. The team is a group of exceptionally talented and dedicated individuals who are committed to advancing the field of astrophysics and making a positive contribution to the world. This is a testament to the power of collaboration and innovation in the pursuit of scientific discovery. The team is a symbol of hope and inspiration, and it will continue to be a source of wonder and fascination for years to come.

By Ed Fraenkel
One physics faculty member's efforts to engineer a more efficient solar energy cell are being created with the help of his students through the means of the news.

Assistant Professor Erik Helgen joined CSUEB after working at the University of California, Berkeley, where he conducted research on silicon solar cells. Armed with a research background, Helgen arrived in Cal State East Bay in Fall 2006 ready to continue his work in the lab, with the addition of student assistance.

"The type of research I've been working on is particularly interesting for incorporating undergraduates as part of the research plan," Helgen says.

In January 2009, Helgen's group took space in the corner of the North Science Building at the Hayward campus. On an average day, sunlight struggles to brighten the otherwise dark lab. It is here that Helgen and his students search for ways to illuminate alternative solar energy cells.

The lab contains all the traditional makings of a scientific laboratory, but among the books, microscopes, slides, and chiral-referred techniques, there are two rooms that look like something from a sci-fi film from decades past. Nestled beside the door is the "glow box." Long lusterous gossamer threads into the floor glass piece allow researchers to manipulate objects within the box without coming into contact and contaminating the material inside. At the center of the room stands a thermal evaporation chamber, a silver contraption resembling a simpler XPS. The chamber and the glow box are critical pieces of equipment in Helgen's research on alternative solar energy cells.

Instead of conducting research on silicon solar cells — which make up 95 percent of solar cells used commercially — Helgen is looking at organic polymers as an alternative to the widely produced silicon cells. While silicon cells, the same type used in computers, have been most efficient at converting energy from the sun, the cells are expensive to produce and do not facilitate passing through to the cells. Organic polymers, including the P3HT Helgen works with, are cheaper to construct and are more available.
Erik Helgren, assistant professor of physics, demonstrates how the thermal evaporating chamber transforms a pellet of copper or aluminum into thin metal films used in creating polymer solar cells.
Appendix B - Physics in the News articles

"The polymer can be spun on a plastic sheet, sprayed on, and comb-thinned," Helgren says.

But there's a hurdle to making polyacrylate solar cells: reduced efficiency. While silicon solar cells can capture and convert sunlight at an approximate 15 percent efficiency rate, the polyacrylate efficiency rate ranges from 5 percent to 5 percent, says Helgren.

"This is where Helgren hopes his research will pay off. He and his student assistants are looking at the material properties of polyacrylate cells and investigating how to improve their efficiency.

Inside the lab, Helgren and his students construct, manipulate, and experiment on the polymer solar cells. Several students have worked in Helgren's renewable energy research lab, including an intern from Corona Costa Community College and UCIrvine students whose majors range from physics to other studies including one who hopes to become a midwife.

Assisted by the opportunity to work in a campus laboratory, physics major Laura Billings relocated to Cal State Fullerton from DeVry Community College during fall quarter.

"I like to be in the lab, whether it's for a grade or not," says Billings, during a break from her studies. "I'm passionate about physics. It's something that I'm interested in just doing to do it."

Billings did not assume he'd get to work in a lab right away when he arrived at the University, so he was excited when Helgren invited him to work alongside him.

"I crammed some numbers, came up with ideas, carry heavy things." Billings says. Throughout fall quarter, Billings' time was focused on preparation of the polyacrylate polymer.
 Aerosol deposition, including taking measurements, testing the power supply, and cleaning and placing parts in the chamber.

The vacuum chamber of the thermal evaporator was completed in December. In the vacuum environment, thin metal films are created to produce the polymer stack. The film layers must be transparent enough to allow sunlight to hit the polymer cell sandwiched between the film. Tiny droplets of metal, typically copper or aluminum, are loaded into the machine, where they are metered and coated on glass slides. In January, Heggen’s students were trained on how to safely run the machine and move the films.

Applying polymer to the films requires a painstaking procedure. The polymer layer is applied inside the glove box to keep oxygen from contacting the polymer. If oxygen reaches the polymer, it will cause the organic material to oxidize, making the polymer useless. Heggen explains. Oxygen is purged out of the area for the glove box and replaced with an alternative gas, such as nitrogen.

Heggen and his team have been trying to improve the cell efficiency by adding carbon-based derivatives to the cell. Early results with nanotubes, published research papers report, did increase the efficiency, but the process is still being studied. On the nanoscale, how the polymer blends absorb more sunlight and the colliding of molecules and polymer conduct current better. The cell is one of the research questions he and students are exploring, Heggen says.

After adding the nanotubes and finishing construction of the solar cell, Heggen’s team monitors the polymer cell outside the glove box and tests its efficiency using voltage measuring equipment. They then analyze and interpret the outcomes.

“Ideally, we would find some really great breakthrough on how to increase the efficiency of polymer solar cells,” Heggen says.

“I’d like to see results from the research to have the feeling of accomplishment that we need here,” Biddle adds. “Not if the accomplishment is just making newer the vacuum chamber is still moving.”

Heggen hopes to publish his team’s findings and extend and present at scientific conferences. Biddle, for instance, may go to present at an upcoming conference at the Applied Photovoltaics School in Monterey, Ca. In his high school chemistry classes recently received a grant from the National Science Foundation to purchase new research equipment. Heggen and his students also will benefit from the grant by receiving commercial-quality equipment, which is expensive and hard to come by.

“Students would get hands-on experience using this high-performance equipment and other researchers involved in solar energy manufacturing and renewable energy, Heggen explains.

For Biddle, experience working in the lab means the promise of bringing closer to his dream job of working in a full-scale industrial setting. Working on a funded project offers additional rewards.

“His pop culture,” he says, “is making devices, producing cells, so his work is going to be in the next generation’s solar cells. It’s something that can impact a lot of scientific breakthroughs.”

Heggen, on the other hand, maintains a long-range vision about the relevance of his research. It addresses an important, and growing, need: the future of energy.

“We are dependent on the use of alternative and renewable energy sources to support our future economy and a country that is dependent on the use of alternative and renewable energy sources to support our future economy,” Heggen says.

Heggen will share his vision of converting the use of fossil fuels and developing alternative methods, such as polymer solar cells, in his research and eventually, he hopes, by developing the polymer solar cell process. At Cal State San, Biddle, but for now, he hopes his research for a breakthrough in the polymer solar cell field, addressing the energy problem and contributing to a brighter future.

**Carbon Nanotubes**

Carbon nanotubes, long tube-shaped molecules of graphite carbon, are one of the thinnest materials. As individual molecules, carbon nanotubes are 100 times stronger than steel, but about 15 percent lighter. Due to their extreme efficiency in conducting electricity and heat, academic and commercial researchers are exploring uses for nanotubes in energy cells and as possible replacements for copper wires in energy grids.
INDEPENDENT THINKERS

FROM A KERNEL OF A CONCEPT GREAT FACULTY RESEARCH GROWS

Jerry Liu also took action when the object of his research, Google rock, revealed a disturbing, potentially criminal pattern. He turned over his findings to the Securities and Exchange Commission, which has made an arrest subverting Liu’s study.

In the College of Science, colleagues in neighboring laboratories in disciplines as divergent as physics and geology are making discoveries that could alter accepted wisdom about how the world works, potentially shaking up our understanding of Einstein’s theory of gravity and the origins of life.

In the following pages, meet a handful of faculty members whose thought leadership is pushing scholarship — and students’ minds — into compelling, previously uncharted territory.
Two laboratories in Cal State Fullerton's science complex are exploring the far edges of human knowledge and demonstrating the breadth of scientific research at the university.

In North Science 247, Assistant Professor Derek Kimball is looking at how basic laws of physics apply to individual atoms. Three doors down in North Science 253, Professor Jeff Seta, chair of the earth and environmental sciences department, is exploring perhaps the biggest question of all: how life arose in our universe.

On the surface the two projects couldn't be more different, but they share certain characteristics. Both are funded by outside grants, both rely heavily on student participation, and collaboration with other institutions, both involve relatively modest equipment and both projects mean their researchers justifiably proud — and even a bit giddy.

Kimball's experiment revolves around a steel drum about the size and shape of a trash can. The drum, surrounded by lasers, mirrors, and sensors, is a shield that reduces magnetic fields — most importantly, the field produced by the earth — by a factor of 10 million. Inside this shield Kimball places delicate glass spheres — he calls them "Christmas ornaments" — containing two different isotopes of boron-11, which emit gamma rays. Laser light also excites the atoms to acquire and measure the difference in spin of the ground state and their excited state.

The goal of Kimball's experiment is to determine whether gravity alone causes those atoms to change the axes about which they spin. "Imagine and it would not," Kimball explains. "We're seeing whether it could, and doing so 100 times more precisely than it's ever been done before." If the axis does change, Kimball says that the theory of gravity will have to be radically revised.

On a more practical level, the experiment could also contribute to developments of extremely precise atomic clocks for navigation.

A three-year grant from the National Science Foundation supports Kimball's project — in fact, his is the first nationally funded experiment for the physics department. Since work started, more than 20 CSUF students, mostly undergraduates, have worked on the project — a fact Kimball says is vital to the University's mission. "The interface between research and teaching at the university level is so important," he says. "The students get hands-on experience, and it motivates the professors."

Down the hall, Seta is similarly motivated — but toward a goal that, at first glance, seems unusual for a geology major: the study of the origins of life.

For his research Seta applies his understanding of how substances behave in extreme conditions, a subject he previously studied at Oak Ridge National Laboratory in Oak Ridge, Tennessee. There he studied gas molecules in water, which had applications for geothermal energy, as CSUEB Seta is looking at how a broad range of organic molecules, including gases and some, and syringes, behave at high pressures and temperatures.

These organic molecules form the basis of energy-processing systems in living creatures. "This research supports the hypothesis that life arose in a high-pressure, high-temperature, aqueous environment, like the black smokers (chimney-like central hot spring) on the ocean floor," he says, adding, "There are lots of environments in the solar system that are very similar."
ASSISTANT PROFESSOR ALLEGES GOOGLE SHARE PRICE MANIPULATION

BY KIM GAULD, D.

It didn’t take long for Assistant Professor of Finance Jerry Liu to figure out that something fishy was going on with Google’s stock after the company’s initial public offering.

Eight months after he posted a paper online about investor manipulation of Google stock during 2006 and 2007, Liu received a devastating news. The Securities and Exchange Commission and FBI arrested Raj Rajaratnam, founder of New York hedge fund management firm Galleon Group, in part for allegedly participating in Google-related insider trading.

While Liu took no red cards for Rajaratnam’s October 2009 arrest, he says the charges completely aligned with his research about Google stock manipulation. Liu’s research was published online in February 2009 and his findings later supported by Forbes.

“My results were confirmed by the arrest,” Liu says.

The SEC alleges Rajaratnam received information about Google’s earnings release from an insider and used that information to benefit his hedge fund. The SEC says Rajaratnam sold shares worth $12 million before the release.

“While securities manipulation is a significant issue, it’s also a challenge,” he says of his collaboration. “The novel thing is that we actually have an experimental device that allows us to test our ideas.”

In studying changes in Google’s stock price, Assistant Professor Jerry Liu uses a computerized device that allows him to test his ideas — he is committed to finding those that prove statistically significant.

“Strangely enough, the system works. It is able to identify the system which is manipulated,” Liu says. “With the right combination of price and other factors, we can recover the information.”

In studying the changes in Google’s stock price, Liu’s research has helped to uncover a few key findings:

1. The system allows for the manipulation of the market, but it is not an easy task.
2. The system is not foolproof, and there is still room for improvement.
3. The findings have potential implications for the financial industry and for the regulation of insider trading.

Liu continues to conduct research on the topic and has plans to expand his work in the future.

If we want to be able to describe life, and the origin of life, we have to have a chemical model. And that chemical model is only as good as our ability to predict chemical behavior.”

Jeff Seitz
PHYSICS, EARTH AND ENVIRONMENTAL SCIENCES
Appendix C - Assessment Tools and Data

Course Descriptions and Learning Outcomes

1001, 1002, 1003, 2004 General Physics (5 units each) All major fields of physics are explored in this sequence. The sequence is designed for physics, physical science, engineering, geology (B.S.), and chemistry (B.S.) majors. Prerequisites or co-requisites: MATH 1304, 1305, and 2304. Each course is a prerequisite of the one following. Four hours lecture, 3 hours laboratory per week.

Physics 1001 – General Physics: Kinematics, Newton’s laws of motion, forces and dynamics, momentum, energy, rotational motion and angular momentum, gravitation.

Physics 1002 – General Physics: Oscillations, fluids, thermodynamics, waves, optics.

Physics 1003 – General Physics: Electric potentials and fields, magnetic fields, electronic circuits, electromagnetic waves.

Physics 2004 – General Physics: Relativity, quantum mechanics, atomic and molecular physics, nuclear and particle physics. This course is a bridge to upper division work in the sciences, and special emphasis is placed on advanced mathematical techniques and problem-solving skills.

Learning outcomes for 1001, 1002, 1003, 2004 General Physics: The primary goal of the General Physics sequence is to help students understand the fundamental physical principles and relationships that govern nature. Beyond this specific content of the courses, the main goals of the sequence are to assist students in discovering how to learn technical subjects and to solve complex technical problems in a rigorous, scientific manner.

Crucial for the solution of practical, real-world problems is knowing when, how, and where to make simplifying approximations, how to evaluate if solutions make intuitive physical sense, and being systematic in the approach to a problem. These goals are emphasized through the activities of the course: focusing on solving applied problems related to the course content in class, in homework, in the laboratories, and on exams.

Of course, to see how to approach a problem, the first hurdle is to understand the physical concepts involved in the situation, which is emphasized through explanations and derivations of important physical laws and relationships, experimental demonstrations in class, laboratory experiments, and conceptual questions presented in-class as peer-to-peer learning activities and conceptual questions on exams (short answer and multiple-choice).


Physics 3102 – Analytic Mechanics II: Central force problems, noninertial frames, rotational motion of rigid bodies. Coupled oscillators and normal modes. Hamiltonian mechanics and investigation of advanced topics such as nonlinear dynamics and chaos. Prerequisite: Physics 2004.


Physics 3152 – Thermal and Statistical Physics II: Quantum degenerate gases (fermions and bosons), Helmholtz and Gibbs free energies, chemical equilibrium, phase transitions. Prerequisite: Physics 3151.

Physics 3180 – Computational Physics: Project-based laboratory focusing on applications of computer programming and numerical techniques to a variety of problems in theoretical and experimental physics, including data acquisition and analysis. Prerequisite: Physics 2004.

Physics 3280 – Electronics: Project-based laboratory focusing on design and construction
Appendix C - Assessment Tools and Data

of analog and digital circuits useful for modern experimental physics. Electronic circuits using diodes, transistors, amplifiers, oscillators, counters, and timers are studied. Prerequisite: Physics 2004.

Physics 3281 – Experimental Physics: Hands-on, project-based experimental laboratory exploring a variety of important fields of physics. Emphasis on experiment design and construction, signal-to-noise analysis, data acquisition and analysis techniques, understanding instrument properties (calibration, resolution), reading and writing scientific papers/reports, giving scientific presentations. Prerequisite: Physics 3180 or 3280 or consent of instructor. Two hours lecture, six hours laboratory.

Physics 3283 – Advanced Laboratory: Advanced experimental projects exploring, for example, subjects in atomic, molecular, and optical physics, condensed matter physics, nuclear and particle physics, and nonlinear dynamics. Prerequisite: Physics 3180 or 3280 or consent of instructor. Two hours lecture, six hours laboratory.


Physics 3999 – Issues in Physics: Readings, discussion, and research on contemporary and/or significant issues in physics. May be repeated for credit when content varies, for a maximum of 8 units.


Physics 4250 – Selected Topics: Various subjects and projects providing an extension of the physics curriculum. Prerequisite: Physics 2004. May be repeated for credit for a maximum of 3 units.

Physics 4600 – Solid State:


Physics 4850 – Undergraduate Research: Research leading to a formal report or presentation, under the direction of a faculty mentor. Co-requisites: Physics 3281 or 3283. May be repeated for credit, for a maximum of 3 units. Three to nine hours of activity/laboratory.

Physics 4950 – Physics Capstone: Comprehensive overview and synthesis of undergraduate physics. Particular emphasis on solving an extensive array of problems covering all subjects in physics. Must be taken in Spring quarter immediately preceding graduation.
Appendix C - Assessment Tools and Data

Introductory and General Physics Pre- and Post tests.

Physics 2701/1001 Conceptual Survey

1. If an object is moving, does that mean a force is acting on the object?  
   Y    N

2. If you throw a rock up in the air, is the rock accelerating (changing velocity) when the rock reaches its highest point?  
   Y    N

3. If the rockets of a space ship in outer space (far from all gravity, no air resistance) suddenly lose power and go off, the space ship will slow to a stop.  
   T    F

4. If you push on a very heavy box and it doesn’t move, it’s because the force due to friction with the floor is canceling out the force you’re applying to the box.  
   T    F

5. If you kick a football toward the goalposts and there is no air resistance, the only force acting on the football as it travels through the air is gravity.  
   T    F

6. A satellite in orbit around the earth is accelerating (changing its velocity).  
   T    F

7. In order to get an object moving you must push harder on it than it pushes back on you.  
   T    F

8. A satellite in orbit around the earth pulls just as hard on the earth as the earth pulls on the satellite.  
   T    F

9. If you push on a heavy box and it doesn’t move at all, have you done any work on the box?  
   Y    N

10. The earth’s gravity is due to the fact that the earth spins about its axis.  
    T    F

11. If the forces on an object balance each other (add to zero), that means the object isn’t moving.  
    T    F

12. A young girl wishes to select one of the frictionless playground slides illustrated below to give her the greatest possible speed when she reaches the bottom of the slide. Which one should she pick?  
    ___ (1) (put a check in front of your answer)
Appendix C - Assessment Tools and Data

PHYS 2702/1002 Assessment

TRUE/FALSE. Write 'T' if the statement is true and 'F' if the statement is false.

1) Heat can be transformed into work with 100% efficiency, but work cannot be transformed into heat with 100% efficiency.

2) As you add heat to boiling water, its temperature gets higher and higher.

3) When an object is floating, the buoyant force on it is just equal to its weight.

4) Two neutral objects cannot attract each other electrically because they have no excess charge.

5) If the electrical potential in a region is constant, the electric field must be zero everywhere in that region.

6) If there is an electric field inside of a conductor, then current must be flowing through this conductor.

7) If a 75 W bulb and a 100 W bulb are connected in series across a 120 V outlet, the 75 W bulb will dissipate 75 W of power and the 100 W bulb will dissipate 100 W of power.

8) A compass is placed close to a stationary charge. If the charge remains stationary, the compass will not deflect, but if the charge moves, the compass will deflect.

9) According to Lenz’s law, the induced current in a circuit must flow in such a direction to oppose the flux through that circuit.

10) A step-up transformer lowers current but raises voltage.
## Introductory Physics Assessment Data

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Overall, we observe significant improvement (20-30%) in student scores on the conceptual survey after instruction:
Before instruction, performance on the true/false exam is no better than random (50%), and in many areas much worse than random. After instruction, performance is significantly improved. In particular we can see improvement in areas of student misconception:

As a baseline we can observe that compared to performance on the question concerning gravitation upon which no instruction was provided from 2008-2010 in the first quarter of the sequence, there is significant improvement in student performance.

At the same time, it is sobering to see that in spite of many changes and innovations to the course content from 2007-2010, overall improvement in student performance is essentially unchanged. Obviously an aspirational goal is to achieve 90-100% performance for the class in the post-course conceptual test, but so far no particular path to such a goal has been identified from our assessment studies. In the future we plan to revise our pre- and post-course assessment during the next five-year review cycle to capture data on problem-solving skills and laboratory skills, which the physics faculty universally deems to be of great importance.
Appendix C - Assessment Tools and Data

## Seminar Evaluation

Name of Speaker: ___________________________  Date: __________

Title of Seminar: ___________________________

<table>
<thead>
<tr>
<th>Criteria</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>Score</th>
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<tbody>
<tr>
<td><strong>Organization</strong></td>
<td>Audience can’t understand presentation because there is no sequence of information</td>
<td>Audience has difficulty following presentation because speaker jumps around</td>
<td>Speaker presents information in logical sequence which audience can follow</td>
<td>Speaker presents information in logical, interesting sequence which the audience can follow</td>
<td></td>
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<tr>
<td><strong>Subject Knowledge</strong></td>
<td>Speaker does not have grasp of information and cannot answer questions about subject</td>
<td>Speaker is uncomfortable with information and is able to answer only rudimentary question</td>
<td>Speaker is at ease with expected answers to all question but fails to elaborate</td>
<td>Speaker demonstrates full knowledge by answering all class questions</td>
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<tr>
<td><strong>Graphics</strong></td>
<td>Speaker uses superfluous graphics or too few graphics</td>
<td>Speaker occasionally uses graphics that don’t support presentation</td>
<td>Speaker’s graphics relate to text and presentation</td>
<td>Speaker’s graphics explain and reinforce screen text and presentation</td>
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<tr>
<td><strong>Mechanics</strong></td>
<td>Presentation has four or more misspelling/grammatical errors or graphics which are too small</td>
<td>Presentation has three misspelling/grammatical errors or graphics which are too small</td>
<td>Presentation has one or two misspelling/grammatical errors or graphics which are too small</td>
<td>Presentation has no misspelling/grammatical errors and no graphics which are too small</td>
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<tr>
<td><strong>Eye Contact</strong></td>
<td>Speaker reads all of report with no eye contact</td>
<td>Speaker uses occasional eye contact but still reads most of report</td>
<td>Speaker maintains eye contact but occasionally reads from notes</td>
<td>Speaker maintains eye contact and doesn’t read from notes</td>
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<tr>
<td><strong>Elocution</strong></td>
<td>Speaker mumbles, incorrectly pronounces terms and speaks too quietly to hear in the back</td>
<td>Speaker’s voice is too low so audience has trouble hearing all of the presentation</td>
<td>Speaker’s voice is clear, correctly pronounces most terms, audience can hear all of the presentation</td>
<td>Speaker uses a clear voice and correct, precise pronunciation of all terms</td>
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<tr>
<td><strong>Understandability</strong></td>
<td>I could not understand anything, I was completely lost.</td>
<td>I somewhat understood the main points, yet not to the fullest level.</td>
<td>I understood the main points of the talk except for the technical parts in the method section.</td>
<td>I understood most of the talk including the principles of the methods.</td>
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The one aspect this presenter did best:

The one aspect this presenter could improve:
### Appendix C - Assessment Tools and Data

#### Capstone Physics Assessment Data

Normalized score on Physics GRE exam

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<td>2009</td>
<td>605</td>
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<td>2010</td>
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Appendix D - Tenure Track Requests

Department of Physics request for TT search in 2007 – 08

The department of physics is critically understaffed and in need of an additional faculty member. Justification for this request is as follows.

1) At the end of the 2005 – 06 academic year we had one faculty member at 50% FERP retire, and one full time tenured professor go to 50% FERP, resulting in the equivalent loss of one full time faculty member. Our FTES have increased by 18% since this separation.

2) Numerical evidence of our faculty shortage can be seen in the percentage of FTE taught by TT faculty which is 61%. Hiring another faculty member will result in 78% classes taught by TT faculty, close to the system wide goal of 75%.

3) The department of physics is a small academic department, which leads to several peculiar problems that may not be evident elsewhere on campus. Factoring in the chairs administrative release time reduces percentages in (2) to 54% and 72% with an additional faculty member.

4) 67% of the full time TT faculty (2 out of 3) received release time for professional activities this academic year. It is anticipated that in the next academic year these faculty members will have a total of 24 WTU release time. Combined with the chairs release time this effectively removes over one full time TT faculty member, taking us from 3.5 to 2.5 – a difference of 30%.

5) A healthy academic department requires a certain “critical mass” of active faculty members. While this number may be hard to define it is definitely more than two or three. Multiple faculty members are needed to shoulder the out of class responsibilities of running a department such as advising, involving students in research, and updating the curriculum in our degree and courses. For example, the department offers 38 different classes, 12 of these being labor intensive laboratories. There is simply no way that three faculty members can maintain and update the curriculum in these courses, and hence students that take physics courses (required for biology, chemistry, engineering, geology, and of course physics majors) ultimately suffer.

Jason Singley
Chair, Department of Physics
5/1/07
Appendix D - Tenure Track Requests  
Department of Physics TT request, Fall 2010  

Justification:

1. Brief overview of the position.

The Department of Physics seeks a tenure track hire for the Fall of 2012 with a specialization in Atomic Physics. The department FTES has increased by 125% over the past five years and we expect further growth in the near term. A new hire is needed to maintain the quality of our programs in the face of this growth. The department has one other faculty member working in atomic physics that has built up an impressive research program here at CSUEB in the past five years, having brought in over a million dollars of external funding. The department would like to leverage this success by hiring another faculty member to work on closely related problems and broaden our atomic physics program here at CSUEB.

In addition to helping the department meet its growing teaching load the hire is needed for curriculum development and increasing the number of research opportunities for undergraduates. The department sees undergraduate research as a vital component to its undergraduate program, but current faculty can not keep up with student demand. The department has seen a steady increase in its teaching load in the past several years, so that now more than half of our classes are taught by part-time lectures. The faculty hire would teach courses throughout the curriculum: in general education, service courses, and major’s courses.

While the department first priority is on hiring an experimental atomic physicist who would create research opportunities for our students, we would also consider hiring an outstanding candidate interested in both physics education research and more broadly participating in the University’s science education programs for pre-service and in-service teachers. This is an area where there is substantial demand for faculty at the department, college and university level.

2. How does this position help the department meet its strategic goals, those of the College, and those of the University?

One of the main goals of the department is to promote faculty and in turn student participation in physics research. Hiring a fifth full-time faculty in the department would significantly enhance the amount of research occurring in the department. Not only will this allow us to better serve our current students, but it will help the department to continue to build a reputation as an outstanding undergraduate physics program.

A key strategic goal of the University is to become a leader in the area of STEM education. This will only occur by hiring quality faculty to help build up our departments in the STEM area. A new physics hire will improve the department’s ability to train both professional physicist and future physics teachers in our major as well as other science and engineering professionals through our service courses.
Appendix D - Tenure Track Requests
3. What are the three most pressing needs to be filled by this position? Curricular gaps? Student Demand? Accreditation requirements? Other?

1) Student Demand - The department has experienced a 125% growth in its FTES taught over the past five years (see Chart 1 below). Over that same period the number of full time tenure track faculty has decreased by 11%. This has led to the majority of our classes now being taught by part-time lectures. In addition to this overall strong past growth, there are a few areas where we anticipate additional growth in the immediate, or near term.

- **PHYS 2701, 2702, 2703** - This Introductory Physics sequence intended mainly for life science majors has grown by 71% over the past 5 years. The class is typically now offered with 50% more students than the official capacity. The department will need to start offering additional sections next year to manage current growth, not to mention anticipated growth based on the past five years.

- **PHYS 1001, 1002, 1003, 2004** - This is the General Physics sequence taken by physics, chemistry, and engineering majors. The class has grown over 120% in the past five years. It is now taught near its capacity, and will require additional sections to sustain the past growth. It is worth noting that CSUEB has a relatively young engineering department that is still in a strong growth mode. The growth of the engineering program is likely fueling the growth we see in PHYS 1000. As the engineering department continues to grow, the departments that help serve its students will also need to grow concomitantly.

- **Annual upper division courses** - About ten years ago the department of physics experienced a very strong decrease in the number of majors enrolling in the program. To deal with this, the department started offering upper division courses only every other year. While this did help the department maintain a satisfactory SFR, the downside was the department was no longer able to distinguish between junior and senior level courses. Additionally, upper division topics could no longer be taught in a logical order, since half the class would likely not have the necessary pre-requisites. In the last 5-year review one of the main recommendations of the outside reviewer was to bring back the annual upper division courses. The department has made significant progress in increasing the size of the major, and we anticipate being in a position to offer annual upper division courses in the next few years. This will significantly increase the teaching load in the department and will not be possible with additional full time faculty.

2) Research Opportunities for Undergraduates - The department has only two faculty members that have active research laboratories where students can participate in physics research. These faculty members typically mentor 5-10 undergraduates a year, which is a substantial additional uncompensated workload. Our research laboratories are a critical component of our training of STEM professionals, where they have a chance to apply their knowledge learned in the classroom to real world situation. Many of our alumni have reported that their undergraduate research experience was critical for them to both find employment and excel in their chosen profession. An additional faculty member will allow us to distribute the extra workload of mentoring students and provide more choices for students choosing a research project.

3) Curriculum Development - With four full time faculty responsible for the curriculum of 205 FTE, the department is struggling to keep its course offering current. This is especially challenging in an experimental science like physics, where the major involves many laboratory courses. In our Introductory Physics sequence alone we have 30 experiments. Updating and revising just one experiment can be a major undertaking. Our upper division laboratories are a
Appendix D - Tenure Track Requests

Place where we are in desperate need of curriculum development. In order to maintain a high quality program that prepares our majors for the workplace, we can not continue to rely on curriculum that was developed decades ago. An additional faculty member will allow the department to make better progress on key areas of curriculum reform.

4. If student demand is a key driver of this position, please analyze student demand over the past 5 years and how this position will help meet that need. Additionally, please describe how this position will impact the availability of part-time funds? Can the department afford a full-time hire, while maintaining a sufficient number of part-time lecturers to meet demand?

Over the past five years, the department FTE has increased by 125% (see Chart 1 below). In the Fall of 2009, the department had 83 WTU allocated. Nominally, four full time faculty can only cover 48 WTU or 58% of this teaching load. In reality the fraction is significantly less due to chair release time, and release time due to faculty research grants. With a fifth faculty member the teaching load of full time faculty would be 60 WTU or 72%, not including release time. Therefore, even with the current teaching load and an additional faculty member the department would need about 1.5 FTEF of lectures.

![Annualized FTES Chart](chart.png)

Chart 1. Average quarterly FTES over a five year period.

As discussed above in response to question 3, the department expects its teaching load to grow in the near term. Adding two new lecture sections of Introductory Physics will grow the quarterly WTU to 80. Adding another lecture and lab of General Physics for engineers will increase it to 96 WTU. Finally, offering annual upper division major’s courses will bring the quarterly teaching load to 107 WTU. Therefore it is likely that even with a new hire in 2012, the amount of work for part-time faculty will be more than it is now.

5. Does the department/school have a strong reputation and can it be made one of the strongest in the region/country by the addition/replacement of one or more faculty members?
Appendix D - Tenure Track Requests

Over the past five years the department has established a strong reputation in the areas of atomic physics research and science education. The department faculty have brought in close to one million dollars in external funding in each of these areas. The research program we have in atomic physics is on par with the research groups at Stanford and UC. However, these are primarily graduate student based research programs, whereas the CSUEB is an undergraduate only program. Indeed, the department just installed a state of the art frequency comb, funded by NSF. This is a tool used in atomic physics research that only a handful of institutions in the US have. We expect that the new faculty hire would do research on this instrument with students. Without a doubt, students working in the atomic physics group are getting a top notch education both in the classroom and laboratory. Hiring another faculty member in atomic physics will allow us to offer more of our students the chance to work in a cutting edge research group and gain critical real world skills necessary for STEM professionals. The hire will further help establish CSUEB as having the premier undergraduate physics program in the region.

It is also worth noting that a hire in science education would also have a significant impact on the department, college and university’s STEM education programs. Currently, faculty in the department are working on six different externally funded pre-service and in-service STEM teacher programs. There are several programs where a new faculty could immediately join and start contributing. Additionally, a new faculty with a science education focus could lead a fledgling program aimed at producing more physics teachers.

Please describe briefly;

6. Faculty Composition.

Please reference Table 1 below for data in this section.
## Appendix D - Tenure Track Requests

### Physics

#### Fall Quarter

<table>
<thead>
<tr>
<th>A. Students</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Undergraduate</td>
<td>20</td>
<td>22</td>
<td>19</td>
<td>26</td>
<td>26</td>
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<tr>
<td>2. Graduate</td>
<td>1</td>
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<tr>
<td>3. Total Number of Majors</td>
<td>21</td>
<td>22</td>
<td>19</td>
<td>26</td>
<td>28</td>
</tr>
<tr>
<td>4. FTES Generated</td>
<td>91</td>
<td>112.4</td>
<td>139.6</td>
<td>134.2</td>
<td>205.3</td>
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#### College Years

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<tr>
<th>B. Degrees Awarded</th>
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<th>05-06</th>
<th>06-07</th>
<th>07-08</th>
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<tbody>
<tr>
<td>1. Undergraduate</td>
<td>5</td>
<td>1</td>
<td>6</td>
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<tr>
<td>2. Graduate</td>
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<td>3. Total</td>
<td>5</td>
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<td>6</td>
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#### Fall Quarter

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<th>2009</th>
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<td>3. Total Tenure Track</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
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<tr>
<td>4. Full-Time</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>5. Part-Time</td>
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<td>4</td>
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<td>4</td>
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<tr>
<td>6. Total Non-Tenure Track</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>4</td>
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<tr>
<td>7. Grand Total All Faculty</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>8</td>
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#### Lecturer Headcount

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<th>Instructional FTE Faculty</th>
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<th>2007</th>
<th>2008</th>
<th>2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>8. Tenured/Track</td>
<td>4.1</td>
<td>3.5</td>
<td>3.6</td>
<td>3.7</td>
<td>3.5</td>
</tr>
<tr>
<td>9. Lecturer</td>
<td>1.4</td>
<td>1.7</td>
<td>2.4</td>
<td>2.4</td>
<td>2.1</td>
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<tr>
<td>10. Total Instructional FTEF</td>
<td>5.4</td>
<td>5.2</td>
<td>6.0</td>
<td>6.1</td>
<td>5.6</td>
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#### Lecturer Teaching

<table>
<thead>
<tr>
<th>D. Student Faculty Ratios</th>
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<th>2007</th>
<th>2008</th>
<th>2009</th>
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</thead>
<tbody>
<tr>
<td>11. % Lecturer/Total Instructional FTEF</td>
<td>25.2%</td>
<td>32.4%</td>
<td>39.9%</td>
<td>39.1%</td>
<td>38.2%</td>
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<tr>
<td>12. FTES Taught by Lecturer</td>
<td>27.6</td>
<td>48.1</td>
<td>90.1</td>
<td>76.7</td>
<td>81.9</td>
</tr>
<tr>
<td>13. % FTES Lecture/FTES Generated</td>
<td>30.3%</td>
<td>42.8%</td>
<td>64.6%</td>
<td>57.2%</td>
<td>39.9%</td>
</tr>
</tbody>
</table>

### Table 1. University data on Physics department.
Appendix D - Tenure Track Requests

a. The number of faculty in your department who have left, retired, or are in the FERP program over the last five years; and the dates of those events (a retirement does not automatically justify a replacement.)

Total faculty leaving department from 05 - 06 to present: 1.5

2006 - Daryl Preston finished FERP at 0.5 FTEF
2008 - Robert Good 1.0 FTEF

b. The ratio of tenured/tenure-track faculty to total FTEF in your department

62%. See Table 1 above.

c. Why a tenured/tenure-track faculty position is needed over a full or part-time instructor.

Two of the key goals of this hire are to have a faculty member develop a strong research program in atomic physics and help update our curriculum (see question 3). These are activities that lectures do not participate in.

d. The number of majors and the ratio of majors to tenured/tenure-track faculty in your department.

28 majors
7 majors per TT faculty.

While these are below average numbers for the University, they are very typical for physics departments in general. The majority of our teaching is in general education and service classes.

e. Department/School SFR as compared to the College SFR.

Department SFR for Fall 2009 was 36.8. The department SFR has increased by 120% in the past five years.

f. The need in the context of your five-year hiring plan. (Each Department must have a 5-year hiring plan in place before a new faculty request will be considered. The 5-year plan must emphasize which sub-disciplines within the department are designated as distinctive, and necessitate a T/TT faculty)

In the course of the next five years the department expects to hire two tenure-track faculty members. The number of hires is dictated by both the current need and the expected growth of the department discussed above. The areas of specialty were selected so that the department could build on its areas of strength while maintaining a faculty with diverse interest.

<table>
<thead>
<tr>
<th>Academic Year</th>
<th>Position</th>
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<tbody>
<tr>
<td>2011-12</td>
<td>None</td>
</tr>
<tr>
<td>2012-13</td>
<td>Atomic Physics</td>
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<tr>
<td>2013-14</td>
<td>None</td>
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</tbody>
</table>
Appendix D - Tenure Track Requests

<table>
<thead>
<tr>
<th></th>
<th>2014-15</th>
<th>Science Education</th>
<th>2015-16</th>
<th>None</th>
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<tr>
<td>Table 2. Department of Physics 5-year hiring plan.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
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</table>

7. Curriculum

a. The percentage of teaching in your department which satisfies general education requirements.

30-50%

b. Will online teaching and/or teaching at another campus site (i.e. Oakland/Concord) be a requirement of this position?

Not necessarily a requirement, but the department does teach both online and at Concord. A Science Education hire would likely take over our new Foundational Physics online course.

c. Does the position represent a central component of a CSU, East Bay’s student’s education? How?

Yes. Position will be assigned to teach throughout the curriculum: GE, service courses, and majors courses. New hire will also engage with majors on independent research projects.

8. Scholarship/New Sources of Revenue

a. Address the potential for scholarly success.

The specialization of atomic physics has been chosen to maximize the likelihood of scholarly success. The department has developed a robust atomic physics research program over the past six years, through the work of Dr. Derek Kimball. Dr. Kimball has been very successful in attracting both internal and external funding for the atomic physics group, with the result that the department now has a very well outfitted laboratory. A new hire trained in atomic physics will be able to utilize these resources to immediately start making progress in research, rather than spending several years looking for funding and setting up a laboratory from scratch. Additionally, Dr. Kimball will be in a position to both mentor and collaborate with the new hire.

It is worth making a special note that the department has just acquired a state of the art Femtosecond Optical Frequency Comb. This ~$400,000 ultra-precise laser system is the cutting edge tool now used in atomic physics, and only a handful of institutions in the US have one. The frequency comb was only invented in 2000, and this invention was awarded the Nobel Prize in 2005. This instrument will be central to the research program of the department’s tenure track hire for 2012.

b. Address the potential for external/internal support for scholarship.

The department has had outstanding success in raising external funds for research in the area of atomic physics. As Table 3 below shows, almost $1,000,000 in external funds have been
Appendix D - Tenure Track Requests

raised in the past four years. We expect that with an additional faculty member working in this area the department will see continued external support for its atomic physics program.

<table>
<thead>
<tr>
<th>Grant</th>
<th>Year</th>
<th>Agency</th>
<th>Amount</th>
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<tbody>
<tr>
<td>Search for Anomalous Proton Spin Interactions with a Dual-Isotope Rubidium Magnetometer</td>
<td>2010-2013</td>
<td>National Science Foundation</td>
<td>$309,514</td>
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<tr>
<td>Acquisition of a Femtosecond Optical Frequency Comb and THz Spectrometer for Atomic, Molecular and Condensed Matter Spectroscopy</td>
<td>2010-2011</td>
<td>National Science Foundation</td>
<td>$393,388</td>
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<tr>
<td>Search for a spin-gravity coupling using laser-addressed atomic gyroscopes</td>
<td>2007-2010</td>
<td>National Science Foundation</td>
<td>$254,150</td>
</tr>
</tbody>
</table>

Table 3. External atomic physics research grants in the past five years.

The department also has a strong track record in bringing in external funds for science education projects. The department has been awarded over $750,000 in grants in this area in the past five years. There are several ongoing grants that a new faculty member specializing in science education could join. Additionally, with a University focus on STEM education it is expected that their will be a strong need for faculty PI’s in this area.

c. Is a replacement critical to the scholarly/research/creative efforts of units both in and outside of the department or college? Does the position have the support of other colleges?

An atomic physics hire would mainly have an impact within the department of physics. If a science education specialist is hired, it will have an impact in both the college of science and the college of education where there are often more projects running then faculty to support them.

d. What has the unit done to maximize its current resources (i.e., to help itself?) over the past four years?

Faculty in the department have looked to collaboration both in the department, in the college, and with other institutions to maximize resources for scholarship. Three faculty members have collaborators at UC Berkeley and Lawrence Berkeley National Laboratory that they work with. The most recent hire in the department is beginning a collaboration with another faculty member in the department in the area of solid state physics. Finally, three members of the department teamed up with a faculty member from the Department of Chemistry and Biochemistry to write the successful NSF grant for the femtosecond laser based frequency comb and THz spectrometer. Our request for a new hire in atomic physics follows this tradition of faculty sharing resources and collaborating on projects.

e. Has the department raised funds effectively from external sources? Has it worked effectively with external agencies and constituencies?
Appendix D - Tenure Track Requests

As discussed above, the department has raised nearly a $1,000,000 for atomic physics research from outside agencies. Additionally the department has brought in $750,00 in the are of science education. The department also has been working on its outreach to its alumni base. As a result, last year the department garnered $5,000 in private donations.

9. Recruitment

a. How will your department ensure that hiring is performed with the diversity goals of the University in mind?

Department will put a priority on hiring a woman or candidate of color. We will work with the University Diversity and Equity Officer during our search process.

b. Is there a pressing need for a senior hire (tenured), either to ensure excellence or fill a leadership role?

No

c. Can you collaborate with another department on advertising or other costs of recruitment?

No
Appendix E - Engineering Physics Proposal

Engineering Physics

From the UC Berkeley College of Engineering:

**Engineering Physics.** This program interweaves classical and modern physics, chemistry, and mathematics with their engineering applications. A great strength of the program is its flexibility. The firm base in physics and mathematics is augmented with a selection of engineering course options that prepare the student to tackle the complex problems faced by society. Because the program emphasizes science and mathematics, students are well prepared to pursue graduate studies in physics or engineering.

The Accreditation Board for Engineering and Technology (ABET) is the organization that would need to accredit the Engineering Physics major. They have no specific curricular requirements, but do specify subject areas. There are more specific requirements for an Engineering Physics Masters degree, but not for a Bachelors degree program.

**ABET Criterion 5. Curriculum**

The curriculum requirements specify subject areas appropriate to engineering but do not prescribe specific courses. The faculty must ensure that the program curriculum devotes adequate attention and time to each component, consistent with the outcomes and objectives of the program and institution. The professional component must include:

(a) one year of a combination of college level mathematics and basic sciences (some with experimental experience) appropriate to the discipline

(b) one and one-half years of engineering topics, consisting of engineering sciences and engineering design appropriate to the student's field of study. The engineering sciences have their roots in mathematics and basic sciences but carry knowledge further toward creative application. These studies provide a bridge between mathematics and basic sciences on the one hand and engineering practice on the other. Engineering design is the process of devising a system, component, or process to meet desired needs. It is a decision-making process (often iterative), in which the basic sciences, mathematics, and the engineering sciences are applied to convert resources optimally to meet these stated needs.

(c) a general education component that complements the technical content of the curriculum and is consistent with the program and institution objectives.

<table>
<thead>
<tr>
<th>Subject</th>
<th>UCB*</th>
<th>UOP*</th>
<th>CSU-Stan</th>
<th>CSUEB Proposal</th>
<th>Units</th>
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<td>Math 1304, 1305, 2304, 2305</td>
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### Appendix E - Engineering Physics Proposal

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<td>Quantum Mech</td>
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<td>Solid State Phys</td>
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<td>Expt Phys, Adv Lab</td>
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<td>Technical electives</td>
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<td>2.5y</td>
<td>Drawn from upper division Physics/engineering courses</td>
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<td>Co-Op</td>
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<td>1.0y (full-time)</td>
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<td></td>
<td></td>
<td></td>
<td>133</td>
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</table>

Note that Industrial Engineering requires 144 units for graduation, Physics BS requires 105.
Appendix F - Equipment Requests

**Category #:** 3,4,5,8

**Requested previously: Yes or No** Unit Priority: 1

**ACADEMIC AFFAIRS**

**ANNUAL EQUIPMENT REQUEST FORM**

**Unit:** CSC1  
**Requestor:** Department of Physics

**Item: (Include name, special features, product # and catalog):** Equipment for New Lower Division Physics Laboratory

**Sections. See attached 1st.**

**Quantity:** 1  
**Unit Cost:** $116,760  
**Shipping & Tax:** $10,799  
**Total Cost:** $121,559

Requires contractual service for installation, uncrating, assembly, etc.  
No

**JUSTIFICATION:**

Reason:  
☐ Safety  
☒ Instruction  
☐ Research (Include additional faculty name(s) below):

Program/Programs affected:

Courses: PHYS 1001, 1002, 1003, 1780, 2064, 2701, 2702, 2703

☒ Major  
☒ General Education  
☒ Service: Enrollments: 350 students per quarter

Interdisciplinary:  
☐ Yes  
☒ No  
If yes, Area or Program:

Other funding sources (explain): None

**Written Justification: (Use additional pages if necessary)**

Please see attached proposal.

**Revised:** June 23, 2020
Appendix F - Equipment Requests
New Equipment for Lower Division Physics Laboratory Sections

We are requesting one-time funding to double our capacity to teach the laboratory component of our lower division Physics courses, thereby doubling our enrollment capacity in both the lecture and laboratory and increasing the efficiency (SFR) in which we are able to offer these highly sought after courses.

Currently in the Department of Physics each quarter we teach three lecture sections of the 2700 series *Introductory Physics* course (requires for students taking the B.S. biological sciences, including pre-professional students, B.A. chemistry students, geology and environmental sciences students, and kinesiology students), one lecture section of the 1000 series *General Physics* course (designed for physics, physical science, engineering, geology and chemistry B.S. majors) and one lecture section of the *Elementary Physics* general education course. The total enrollment in these courses has gone up from 250 in fall 2008 to 350 in fall 2009. This increase of 35% is reflective of a longer term increase in the enrollment in these courses and the college of science in general.

The above lecture courses support a combined *sixteen* laboratory sections. Importantly, all of these laboratory sections share one set of equipment, making it impossible to schedule simultaneous lab classes. The department has been creative in its scheduling, but has reached the point where it is impossible to add additional laboratory sections. Due to room capacities, lab safety considerations and pedagogical reasons it is also impossible to increase the enrollment in each lab section. Therefore, the department has reached the point at which it can no longer increase enrollment in its lower division labs and corresponding lecture courses to keep up with student demand.

With the requested one-time grant the department will acquire a second set of laboratory equipment for our introductory physics courses that will allow us to teach two section of the lab simultaneous. The department of physics already has the physical space to offer simultaneous lab sections; therefore the acquisition of this equipment will give us the capacity to double the number of students we serve in these courses. In addition to allowing us to meet enrollment growth, these one-time funds will also have a long term impact on the efficiency of which we teach these classes. For example, each additional 20 student that enrolls in PHYS 1001 will bring in 100 SCU. Since we already have space in the lecture, we will only need to spend 2 WTU to support the extra lab instructor. The result is we are able to enroll additional students at an SFR of 50.
### NEW LOWER DIVISION LAB EQUIPMENT LIST

<table>
<thead>
<tr>
<th>ITEM</th>
<th>QUANTITY</th>
<th>VENDER</th>
<th>COST</th>
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**Total**

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Appendix F - Equipment Requests

<table>
<thead>
<tr>
<th>Category #:</th>
<th>1, 3, 4, 5, 6</th>
<th>Requested previously: Yes or No</th>
<th>Unit Priority:</th>
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</table>

**ACADEMIC AFFAIRS**  
**ANNUAL EQUIPMENT REQUEST FORM**

**Unit:** CSCI  
**Requestor:** Department of Physics

**Laboratory Courses.** See attached itemized list.

<table>
<thead>
<tr>
<th>Item: (include name, special features, product # and catalog):</th>
<th>Replacement Equipment for Lower Division Physics</th>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Unit Cost</th>
<th>Shipping &amp; Tax</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$49,788</td>
<td>$4,854</td>
<td>$54,642</td>
</tr>
</tbody>
</table>

Requires contractual service for installation, uncrating, assembly, etc.  
No

**JUSTIFICATION:**

**Reason:**  
☐ Safety  ☑ Instruction  ☐ Research (Include additional faculty name(s) below):

**Program/Programs affected:**  

**Courses:** PHYS 1001, 1002, 1003, 1780, 2064, 2701, 2702, 2703

☐ Major  ☑ General Education  ☑ Service: Enrollments: 350 students per quarter

**Interdisciplinary:** ☐ Yes  ☑ No  
If yes, Area or Program:

**Other funding sources (explain):** None

**Written Justification: (Use additional pages if necessary)**

The department is requesting one-time funding to replace broken, worn-out, and out of date equipment in lower division physics laboratories. New equipment will allow us to more effectively teach our courses, and additionally will expose students to equipment that they are likely to see as practicing scientists and engineers.

The department of Physics has one set of laboratory equipment that it uses to support the laboratory sections of eight different classes. These are major's courses, service courses for Biology, Chemistry, Engineering, Geology, Liberal Studies, and Kinesiology majors, as well as general education courses. Currently 350 students use this equipment each quarter.

The department has evaluated our current equipment, and identified items in critical need of replacement. We have focused on electronic equipment and experiments used to teach modern physics. Much of the equipment we seek to replace is 25 - 50 years old and either does not work well, or is frequently breaking down. In some cases we are requesting to replace equipment that is out of date and where significantly more effective teaching tools exist.

Revised: June 23, 2020
## Appendix F - Equipment Requests

### LIST OF EQUIPMENT TO UPGRADE LOWER DIVISION LABORATORIES

<table>
<thead>
<tr>
<th>ITEM</th>
<th>QUANTITY</th>
<th>VENDER</th>
<th>COST</th>
<th>TOTAL</th>
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<td>Instek</td>
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<td>$4,800</td>
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<td>Instek</td>
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<td>$7,200</td>
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<td>Data Studio based Spectrophotometer</td>
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<td><strong>Tax</strong></td>
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<td><strong>Total</strong></td>
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<td>$54,642</td>
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</table>
# Appendix F - Equipment Requests

<table>
<thead>
<tr>
<th>Category #:</th>
<th>1, 2, 3, 8</th>
<th>Requested previously: Yes or No</th>
<th>Unit Priority:</th>
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<thead>
<tr>
<th>ACADEMIC AFFAIRS</th>
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<tr>
<td>ANNUAL EQUIPMENT REQUEST FORM</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Unit:</th>
<th>CSCI</th>
<th>Requestor:</th>
<th>Department of Physics</th>
</tr>
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<table>
<thead>
<tr>
<th>Item: (Include name, special features, product # and catalog):</th>
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<table>
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<table>
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<tr>
<th>Reason:</th>
<th>☑ Safety</th>
<th>☑ Instruction</th>
<th>☑ Research (Include additional faculty name(s) below):</th>
<th>Erik Helgren and Jason Singhly</th>
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<table>
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<tr>
<th>Program/Programs affected:</th>
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<table>
<thead>
<tr>
<th>Courses:</th>
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<th>☐ General Education</th>
<th>☐ Service:</th>
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<tr>
<th>Interdisciplinary:</th>
<th>☐ Yes</th>
<th>☑ No</th>
<th>If yes, Area or Program:</th>
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<table>
<thead>
<tr>
<th>Other funding sources (explain):</th>
<th>Department applied for a NSF CCLI grant in 2006 and was turned down.</th>
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</table>

<table>
<thead>
<tr>
<th>Written Justification: (Use additional pages if necessary)</th>
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</table>

See attached proposal.

Revised: June 3, 2020
Appendix F - Equipment Requests

The Department of Physics request funding to purchase an Ellipsometer - a research tool used to determine the optical properties of materials. The instrument will have a dual use: it will be used by faculty researching green energy technologies, material science, and solid state physics; and also as an instructional instrument in our upper division physics laboratory courses.

Ellipsometry measures the change in the polarization as light is reflected or transmitted through a material. This information can yield the thickness of a solid down to atomic level resolution as well as the optical constants of the solid - those parameters that distinguish a metal from a semiconductor from a superconductor. Therefore ellipsometry is an important tool that is used to uncover the microscopic interactions that lead to different properties of matter. The ellipsometer also has broad applications in semiconductor and data storage solutions, flat panel display, communication, biosensor, and optical coating industries. This widespread use is explained by increased dependence on thin films in many areas and the flexibility of ellipsometry to measure most material types: dielectrics, semiconductors, metals, superconductors, organics, biological coatings, and composites of materials.

Over the past several years the Department of Physics has developed a research concentration in the complementary fields of material science and solid state physics. Two faculty members in the department are trained and have research interest in the spectroscopy of solids. Until recently spectroscopic research was limited to work on an out-of-date, donated instrument. However, faculty in the departments of Physics and Chemistry were recently awarded an NSF grant and acquired a very long wavelength (THz) spectrometer. The proposed ellipsometer will be a complementary instrument, allowing faculty to compare material properties at two very different energy scales. The ellipsometer will also provide an accurate measurement of film thickness, a parameter that is necessary to analyze the THz spectrometer data. Finally, our most recent faculty member has used his start up funds to build a thin film deposition system that he is using to create novel photovoltaic materials. The ellipsometer is the ideal tool for characterizing these materials.

In addition to giving students a deep theoretical knowledge of physics the department has a strong commitment to providing relevant hands-on training to our students to prepare them for careers in high-tech industries. One place that this training takes place is in our upper division Experimental Physics and Advanced Laboratory classes. These classes allow students to interact with advanced instrumentation and learn problems solving skills necessary for the science and engineering professions. They also serve to prepare students to do undergraduate research projects with faculty - something we encourage all of our students to do. Unfortunately, much of the equipment is many decades old, and no longer reflects equipment that graduates are likely to use in the future, nor does a good job at building the skills they need to be successful in their professions. In 2006 the department submitted a CCLI grant to NSF to upgrade equipment that was not successful. While we are continuing to look for new funding opportunities, the acquisition of the ellipsometer would be a solid first step at rebuilding these classes while providing a tool that prepares students for more in depth research projects and training for industry jobs.
### Appendix F - Equipment Requests

#### QUOTATION

**Page 1 of 2**

<table>
<thead>
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<th>Customer</th>
<th>California State University, East Bay</th>
<th>Quote #: 1110G-007</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contact</td>
<td>Professor Erik Helgren</td>
<td>Quoted By: Greg Pribil</td>
</tr>
<tr>
<td>E-mail</td>
<td><a href="mailto:erik.helgren@csueastbay.edu">erik.helgren@csueastbay.edu</a></td>
<td>Date: November 5, 2010</td>
</tr>
<tr>
<td>Phone/Fax</td>
<td>(510) 885-4604</td>
<td>Shipping Terms: F.O.B. Origin (Lincoln, NE)</td>
</tr>
<tr>
<td>Ref #</td>
<td></td>
<td>Payment Terms: Net 30 Days upon credit approval</td>
</tr>
</tbody>
</table>

*Conditions:* Prices and terms on this quotation are not subject to verbal change or other agreements unless approved in writing by the Seller. All quotations and agreements are contingent upon availability, terms and conditions, and all other causes beyond seller control. Typographical or stenographic errors subject to correction. Buyer shall not disclose or announce the purchase price without written permission from seller.

<table>
<thead>
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<th>Item</th>
<th>Qty</th>
<th>Description</th>
<th>Domestic Customer Price (in USD)</th>
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<td>60 days*</td>
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<tr>
<td></td>
<td></td>
<td>• 180 Wavelengths from 380 nm to 900 nm</td>
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<td></td>
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<td>• Angles of Incidence: 65°, 70°, 75° and straight-through (90°)</td>
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<td></td>
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<td>• Measurement Speed: 2-3 sec. (fast mode), 10 sec. (standard)</td>
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<tr>
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<td></td>
<td>• Patented Rotating Compensator (RCE). The compensator in the alpha-SE rotates to increase accuracy and provide data over the full psi-delta plane.</td>
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<tr>
<td></td>
<td></td>
<td>• 5-site license of CompleteEASE™ software for data</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>acquisition and analysis. User-friendly software for</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>quick, easy measurement of film thickness and refractive index (n and k).</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Small footprint: 19&quot; wide by 12&quot; deep</td>
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<td>• Sample Alignment: computer automated.</td>
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<td></td>
<td><em>No installation or training required.</em></td>
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<tr>
<td></td>
<td></td>
<td><em>Operator Computer sold separately.</em></td>
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<td>2</td>
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<tr>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>3</td>
<td>1</td>
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</tr>
<tr>
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<td></td>
<td>Core2Quad Q9400 2.66 GHz processor, 2GB RAM, 320GB</td>
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<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>hard drive, Windows 7 Professional, 16X DVD +/-RW writer,</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Microsoft Office 2007 Basic, 19&quot; Flat Panel Monitor.</td>
<td></td>
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</tr>
</tbody>
</table>

Quoted Ship Date is worst case. Please call for better estimate at time of order.
Appendix F - Equipment Requests

Category #: 1, 2, 5, 7, 8
Requested previously: Yes or No
Unit Priority: ____________

ACADEMIC AFFAIRS
ANNUAL EQUIPMENT REQUEST FORM

Unit: CSCI
Requester: Department of Physics
Item: (Include name, special features, product # and catalog): 16 inch telescope with CCD.

Quantity: 1
Unit Cost: $40,000
Shipping & Tax: $3,900
Total Cost: $43,900
Requires contractual service for installation, uncrating, assembly, etc. no

JUSTIFICATION:
Reason: ☐ Safety ☑ Instruction ☑ Research (Include additional faculty name(s) below):
Gary Weston, Louis Villanueva, and Bill Pozzaglia

Program/Programs affected:
Courses: PHYS 1800, 1880, 3281, 3283
☐ Major ☐ General Education ☐ Service: Enrollments: 60 students per year
Interdisciplinary: ☐ Yes ☑ No If yes, Area or Program:
Other funding sources (explain): none

Written Justification: (Use additional pages if necessary)

See attached proposal.
Appendix F - Equipment Requests

Proposal for Telescope

This proposal is for the purchase of 16 inch telescope. The telescope would be used by faculty and students for teaching and research purposes in addition to public viewings. The telescope would allow for projects such as observing the planets and their satellites, observing variable stars, and the detection of extra-solar planet transits. The acquisition of such a telescope would greatly enhance the astronomy program at CSUEB in several ways.

This department is in need of a large telescope that would upgrade the astronomy lab and bring us up to par with neighboring universities and colleges (including community colleges) that have similar-sized telescopes in their astronomy programs. The largest telescopes that exist on our campus are 30 year old 8 inch reflectors with no computer control.

A 16 inch telescope will improve the astronomy laboratory course by providing a state of the art instrument that can be used for instruction, and student and faculty research. A large-aperture telescope would allow for viewing faint objects such as galaxies, asteroids, and comets. The use of a charged-coupled device (CCD) camera would allow us to move the astronomy lab course into a completely new direction. Students will get high quality images of diffuse objects.

This telescope will be used for student research. Students could use this telescope for research on projects such as determining the mass of Jupiter (or Saturn) by monitoring its satellites as they orbit the planet. This type of project would involve the taking of several images of Jupiter and its satellites. Another possible student project would involve measuring the light output of variable stars such as eclipsing binary stars. Fitting the light curve would involve estimating the masses, radii, and surface temperatures of the two stars in a given binary system.

The search for extra-solar planets using the transit technique is an example of research that could be done by faculty together with students. This project might be done in collaboration with the Chabot Science Center and Lick Observatory, which are conducting similar searches.

Another benefit of having a large-aperture telescope with modern computer control would be to use it for public viewing. Public viewings can be done a couple of times a year and can be combined with a short lecture in astronomy. One such public event could be the 2012 transit of Venus across the Sun. This is an event that shouldn’t be missed that occurs in the daytime and not occurring for another hundred years!

Here is a short list of the requested equipment and costs totaling $40,000:

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Estimated Cost</th>
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</thead>
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<td>16&quot; Telescope</td>
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<tr>
<td>Mount</td>
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<tr>
<td>CCD</td>
<td>$10,000</td>
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<td>Computer</td>
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<tr>
<td>Imaging Software</td>
<td>$1,000</td>
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</table>

L. Villanueva, G. Weston, W. Pezzaglia

November 19, 2010
Appendix F - Equipment Requests

<table>
<thead>
<tr>
<th>Category #:</th>
<th>1, 2, 8</th>
<th>Requested previously: Yes or No</th>
<th>Unit Priority:</th>
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</table>

**ACADEMIC AFFAIRS**
**ANNUAL EQUIPMENT REQUEST FORM**

<table>
<thead>
<tr>
<th>Unit:</th>
<th>CSCI</th>
<th>Requestor:</th>
<th>Department of Physics</th>
</tr>
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<tbody>
<tr>
<td>Item: (Include name, special features, product # and catalog):</td>
<td>LindbergBlue Multipurpose Box Furnace 1500°C from Thermo Scientific, Part/Model No. BFS1433C</td>
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<table>
<thead>
<tr>
<th>Quantity:</th>
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<th>Unit Cost:</th>
<th>$16,367</th>
<th>Shipping &amp; Tax:</th>
<th>$2000</th>
<th>Total Cost:</th>
<th>$18,367</th>
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</thead>
</table>

Requires contractual service for installation, uncrating, assembly, etc. No

**JUSTIFICATION:**

Reason: □ Safety  □ Instruction  □ Research (Include additional faculty name(s) below:)

Program/Programs affected:

Courses: Physics 3281 and 3283 - upper division Experimental Physics and Advanced Laboratory

☑ Major  □ General Education  □ Service: Enrollments: 40 students per year

Interdisciplinary: □ Yes  ☑ No  If yes, Area or Program: 

Other funding sources (explain): Department submitted a NSF CCLI grant in 2006 for these classes that was not funded.

**Written Justification: (Use additional pages if necessary)**

See attached proposal.

Revised: June 23, 2010
Appendix F - Equipment Requests

In the Spring Quarter of 2010 the Physics Department attempted a number of new upper division experimental labs to provide students hands-on experience working with equipment, materials and technology that are needed in today's technical and R&D marketplace (the goal of STEM education!). One such project, and by the student's own admission, the class favorite, was a project where each student made a silicon-based photovoltaic solar cell from scratch. In conjunction with Dr. Masiello from the Chemistry Department, the Physics 3281 students and Dr. Masiello's students in his Chemistry 4601 Environmental Chemistry course, were each given a raw piece of a doped silicon wafer (students cleaved the wafers themselves as well). The students then annealed their silicon wafers in a furnace with a Phosphorous-based coating on one side of the wafer. This annealing step causes Phosphorous atoms to diffuse into the doped silicon wafer thereby producing the desired atomic reconfiguration that produces a simple silicon-based solar cell (a p-n junction). After the annealing step, the wafers were cleaned in an acid etch to remove oxide layers and front and back metallic contacts were applied to these solar cells. During the final week of class, the students assembled in the Science quad and measured the efficiency of their cells under the midday sun. Every student was able to measure a voltage being produced by their own solar cell. However the efficiencies that the students observed were much lower than I had expected. The annealing furnace I am requesting, I believe, will dramatically improve the results for this new lab project.

Dr. Helen Zong and Dr. Saeed Motavalli of the Engineering Department were kind enough to allow us to use an annealing furnace in the Engineering Department's Materials Testing Lab. However as I later found out, Dr. Zong uses this furnace to anneal iron (annealing iron changes the material properties, typically giving the cooled iron improved tensile strength). Annealing the iron leaves iron residue on the walls of the furnace. This residue unfortunately makes its way into any other material that is later annealed in the furnace. So when my own and Dr. Masiello's students annealed their silicon in this furnace, iron contaminants also diffused into the solar cells.

In the semiconductor industry, so-called Metal Oxide Semiconductor (MOS) technology refers to the standard processing techniques used to fabricate basically every semiconductor chip. For a tool, such as an annealing furnace or evaporation chamber, to be considered "MOS" clean in the semiconductor industry, it must be free from metal contamination because metallic contaminants, even at the atomic level, ruin the semiconductor's desired behavior. The iron contamination in our silicon solar cells undoubtedly created what are called "deep level traps". In a typical, good solar cell the electrons, freed during the absorption of sunlight, diffuse through the silicon itself to produce the desired electric voltage and current. In our initial attempt at creating solar cells here at CSUEB, undoubtedly the electrons were captured by the iron contaminants, the "deep level traps", producing the observed low-efficiency cells. I am confident that a dedicated annealing furnace that will remain "MOS-clean" for this lab and any future semiconductor processing requirements, will make this student-favorite lab a resounding success in the future.

In summary, this purchase will assist in an upper division experimental Physics lab that teaches STEM-based students techniques and skills that are not only useful but necessary in today's semiconductor and renewable energy technology sectors. I am requesting funding to purchase a similar model Lindberg/Blue M annealing furnace to the one used in the Engineering Department.
Appendix G - Advanced Lab Proposal

Physics of Imaging Quantum Systems (PIQSy) Center

ADVANCED EXPERIMENTAL LABORATORY DEVELOPMENT FOR UNDERGRADUATE EDUCATION

A central education and outreach activity of the PIQSy Center is development of new and innovative advanced experimental laboratory modules and curricula that will be disseminated throughout the affordable, accessible, and diverse California State University (CSU) system (the nation’s largest university system), benefiting a diverse population of undergraduate physics students and strengthening the nation’s scientific human resources.

Given that UC Berkeley’s yearly output of Physics majors is among the largest of all U.S. research institutions, Berkeley’s nationally recognized Advanced Experimental Laboratory facility for undergraduate physics education already has a significant broader impact in the training of the scientific workforce and of scientifically literate citizens. It is widely recognized that collaborative, hands-on laboratory experiences are one of the most critical and useful components of undergraduate education in the sciences [1]. The Berkeley Advanced Laboratory course centers around inquiry-based experiments that facilitate independent thinking, teamwork, and group discussion as well as development of skills in problem-solving, experimental design, and data analysis — the key scientific skills demanded in both industry and research. The broader impact of the Advanced Laboratory program is even more significant considering that UC Berkeley ranks second nationally in the number of physical science degrees awarded to minority students [2]. Involvement in hands-on, state-of-the-art laboratory experiences has been demonstrated to improve retention rates for underrepresented minority students [3], emphasizing the importance of the advanced laboratory for educating a diverse scientific workforce.

Within PIQSy, this broad impact will be extended further by contributing to undergraduate education at several CSU campuses as well as colleges and universities from across the nation, including several historically black colleges (HBCs, see attached letters of support). The CSU system draws in the full diversity of the state of California, educating many students emerging from under-performing schools and from families without a strong educational background. For example, one of the principal partners in the PIQSy advanced laboratory development initiative will be CSU - East Bay, ranked by U.S. News & World Report as the third most diverse regional university campus in the nation. In fact, there are ten CSU campuses among the top 25 most diverse universities in the nation [4], and 21 out of the top 100 universities in terms of degrees awarded to minority students are either UC or CSU campuses [2].

The PIQSy Center at UC Berkeley will partner with three CSU campuses (CSU - East Bay, CSU Chico, and CSU San Marcos) to develop and disseminate four new advanced laboratory experiment modules related to PIQSy research. The experiments and the accompanying curricular materials, including assessment tools to be developed by faculty from CSU San Marcos with expertise in physics education research, will be developed by a team of professors from the CSU campuses, PIQSy Center scientists and the Center’s executive co-director. These innovative and affordable experiments (cost ≤ $10k) will emphasize learning strategies that improve student teamwork, active learning, and both oral and written communication skills.

In the first year, we will design, build, and test a prototype version of an advanced laboratory experiment module at UC Berkeley and at each of the CSU campuses. In the following summer, 5-10 professors from other institutions will be selected to visit UC Berkeley for 2 weeks to build their own versions of the experiment module to take back and use at their home campuses. The cycle of experiment module development and dissemination will repeat in each year of the grant, leading to four new experiment modules.
Appendix G - Advanced Lab Proposal

Full information on the experiment modules [complete instructions (including parts, costs, suppliers, etc.) for construction, curricular materials, and ideas for further exploration] will be made available on the existing UC Berkeley Advanced Laboratory website and ComPADRE, the NSDL site for Physics and Astronomy. Papers describing the experiments will be submitted to the American Journal of Physics, and presentations on the experiments will be given at American Association of Physics Teachers (AAPT) meetings and shared through the Advanced Laboratory Physics Association (ALPhA) collaboration. The cost of materials for each experiment will be held within a budget of $5-10k, so that construction of the experiments at most undergraduate institutions will be possible. Furthermore, a number of companies (ThorLabs and FASCO, see attached letters) have expressed interest in developing affordable commercial kits based on the advanced laboratory experiment modules to be developed at the PIQSy Center.

Potential advanced laboratory experiment modules include:

- **Magnetic imaging with NV color centers in diamond** [MA2]: Recently, a room-temperature scanning probe magnetometer based on NV color centers in diamond has been developed and applied to map nanoscale magnetic field variations [6]. It is feasible to build a low-cost version of such an experimental apparatus and image, for example, magnetic hard drives, magnetic fields from currents in microelectronic components, or domain shifts in ferromagnetic materials.

- **Optical and STM imaging of graphene** [MA1,MA3]: Students can prepare and test graphene samples prepared via chemical vapor deposition and studied with an optical transmission microscope. Fascinating graphene properties can be explored with a home-built atomic force microscope (AFM), through simple optical experiments demonstrating the quantization of optical absorption in units of the fine structure constant [7], and by measuring electronic transport properties.

- **Quantum conduction** [MA1]: A low-cost home-built scanning tunneling microscope (STM) can be used to perform measurements of quantum conduction between gold electrodes using the break junction method [8]. When the STM tip is pulled out of contact with the gold substrate, the conductance decreases in a stepwise fashion, with steps in integer multiples of the conductance quantum $e^2/h$.

- **Low-field magnetic resonance imaging (MRI) with atomic magnetometers** [MA2]: A low-cost MRI system based on room-temperature atomic magnetometry can be developed [9] that allows nuclear magnetic resonance (NMR), electron spin resonance (ESR), and MRI experiments in the earth's magnetic field, eliminating the need for large and cumbersome electromagnets usually employed in such experiments.

Tracking and assessing the PIQSy Center advanced laboratory experiment modules will be performed through surveys of the professors and students at participating institutions, with assessment tools developed by CSU professors with experience in physics education research. The PIQSy Center program offers a significant opportunity to assess the impact of advanced laboratory experiences on the diverse student population at the multicultural, public CSU and UC systems, as well as for participating HBCUs. Identified learning objectives for advanced laboratory experiences (such as understanding of data analysis techniques, experimental design, instrument resolution, etc.) will be quantitatively assessed for the first time to our knowledge. There is a recognized need among the national community of advanced laboratory instructors for more assessment of the importance and benefits of laboratory experiences, and our assessment tools and results will be shared through articles and presentations at AAPT and ALPhA meetings, as well as online.
Appendix G - Advanced Lab Proposal

The benefits and broad impact of these activities are significant and multi-layered. First, the Advanced Laboratory courses of UC Berkeley, participating CSU campuses, and invited institutions nationwide will have improved Advanced Experimental Laboratory programs with important and novel experiments exploring science and techniques at the forefront of research, benefiting all students in these programs and in particular the underrepresented minority students prominent at targeted UC and CSU campuses and HBCs. Second, participating faculty will develop a stronger community of Advanced Laboratory instruction. Finally, the participating organizations will work to bring this curriculum and the national model of UC Berkeley’s Advanced Laboratory to other institutions, exposing thousands of new students to state-of-the-art experimental physics techniques.
Appendix G - Advanced Lab Proposal

References


Memorandum

Date: April 22, 2011

To: Physics Program Review Committee

From: Michael Leung, Dean of the College of Science

Subject: Five-Year Review

I would like first to commend the Chair and the Committee for having completed a thorough and meticulous review of its department. I am also thankful to the external reviewer for having provided valuable input and insight. The department was able to achieve most of the planned goals and objectives outlined in the last review. The program overall is strong in curriculum and faculty have shown impressive teaching performance and professional development. Its number of majors has grown from around 10 five years ago to 29 currently. Even though this is a reasonable number for an undergraduate physics program, I appreciate the department’s stated intent to continue to grow its majors. With careful planning of GE and support course offerings, the department has been able to maintain a SFR of around 30 even with a small number of majors. The department is to be complimented on its impressive achievements in research and grant awards; with external funding amounting to close to 2 millions dollars since 2006. The Committee has done a careful analysis of the current status of their department and has provided well-conceived plans for the future. I am in support of their future plans as outlined in the review. However, I need to point out that all items which require resources for implementation will necessarily rely heavily on availability of funding. This is particularly true when the university is anticipating serious budget reduction in the coming years. Additionally, the college has the responsibility of having to distribute its funding equitably to all departments dependent on the priority of their needs. Overall, I am encouraged by the progress the department has made and look forward to its future accomplishments.

xc: Jason Singley, Chair of Department of Physics
Appendix I - Annual Reports
Department of Physics Annual Report: 2006 – 2007

Self Study

In 2006 the department of physics saw major changes in its faculty, curriculum, and assessment efforts. In the spring of 2006 a senior faculty member retired and another senior faculty member, and at that time department chair, entered the FERP program at 50%. This left the department with one associate professor and two assistant professors. One of these assistant professors took on the role of chair. While a department biased toward a very young faculty has increased the energy in the department and led to new ideas and practices, it has also put an enormous burden on these faculty members.

In the fall of 2005 the department instituted a revised BS and new BA degree. Students are just starting to use this new program and we are eager to see its effects on both recruitment of new students and the professional success of our graduates. Other curricular related changes have been a renewed focus on our general educational course offerings. Since we have a very small major, the enrollment in our upper division classes is small. To offset this we are trying to offer more, large enrollment general educations courses. We offered PHYS 3700, a B6 GE class, in the spring quarter for the first time this year. We also submitted four proposals for freshman clusters for fall of 2007. In the future we will look to offering GE classes on the Concord campus.

The departments’ assessment efforts have been weak in the past and we are now trying to institutionalize some assessment practices. We have completely rewritten our assessment plan and have developed new learning objectives and learning outcomes. We have begun to institute some standard methods for measuring our learning outcomes. Our initial results are shown in the next section. We plan on making further progress in this area in the next year.

While there is a renewed sense of purpose in our department, and we are making strong progress in improving our department, we are unfortunately severely understaffed. We plan on requesting a tenure track hire based on the following rational.

- At the end of the 2005 – 06 academic year we had one faculty member at 50% FERP retire, and one full time tenured professor go to 50% FERP, resulting in the equivalent loss of one full time faculty member. Our FTES have increased by 18% since this separation.
- Numerical evidence of our faculty shortage can be seen in the percentage of FTE taught by TT faculty which is 61%. Hiring another faculty member will result in 78% classes taught by TT faculty, close to the system wide goal of 75%.
- The department of physics is a small academic department, which leads to several peculiar problems that may not be evident elsewhere on campus. Factoring in the chairs administrative release time reduces percentages above to 54% and 72% with an additional faculty member.
- 67% of the full time TT faculty (2 out of 3) received release time for professional activities this academic year. It is anticipated that in the next academic year these faculty members will have a total of 24 WTU release time. Combined with the chairs release time this effectively removes over one full time TT faculty member, taking us from 3.5 to 2.5 – a difference of 30%.
- A healthy academic department requires a certain “critical mass” of active faculty members. While this number may be hard to define it is definitely more than two or three. Multiple faculty members are needed to shoulder the out of class responsibilities of running a department such as advising, involving students in research, and updating the curriculum in our degree and courses. For example, the department offers 38 different...
Appendix I - Annual Reports

classes, 12 of these being labor intensive laboratories. There is simply no way that three faculty members can maintain and update the curriculum in these courses, and hence students that take physics courses (required for biology, chemistry, engineering, geology, and of course physics majors) ultimately suffer.

Assessment Results

1) Students will have a general understanding of the fundamental principles of physics.

Analysis of pre- and post exam given to students in PHYS 1001.

<table>
<thead>
<tr>
<th>Question</th>
<th>% change</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Force and inertia</td>
<td>43.8</td>
</tr>
<tr>
<td>2. Acceleration (turning point)</td>
<td>0.6</td>
</tr>
<tr>
<td>3. Inertia</td>
<td>1.3</td>
</tr>
<tr>
<td>4. Forces (friction)</td>
<td>11.7</td>
</tr>
<tr>
<td>5. Gravity and forces</td>
<td>37.7</td>
</tr>
<tr>
<td>6. Acceleration (circular motion)</td>
<td>8.7</td>
</tr>
<tr>
<td>7. Newton's 3rd Law</td>
<td>3.2</td>
</tr>
<tr>
<td>8. Newton's 3rd Law</td>
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</tr>
<tr>
<td>9. Work</td>
<td>9.7</td>
</tr>
<tr>
<td>10. Gravity</td>
<td>22.2</td>
</tr>
<tr>
<td>11. Newton's 2nd Law</td>
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<tr>
<td>12. Potential and kinetic energy</td>
<td>64.8</td>
</tr>
<tr>
<td>Total</td>
<td>21.5</td>
</tr>
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</table>

Overall, the students’ percent of correct answers increased by over 20%, which is a statistically significant improvement. However, in half of the subject areas (highlighted in Table), we observed little or virtually no improvement in areas that the students were not proficient. In the coming year, more attention and new strategies will be employed in these subject areas and we will assess if student learning has improved by using the same survey.

2) Students should be able to effectively perform a physics experiment, analyze the acquired data, draw meaningful conclusions, and communicate these results to their peers.

An appropriate metric is currently being developed, and will be integrated into our upper division laboratories (PHYS 3281,3)

3) Students have in-depth knowledge of the foundational subjects in physics (primarily analytical mechanics, quantum mechanics, thermodynamics and statistical mechanics, and electrodynamics).

Students enrolled in our capstone class, PHYS 4950 were given a physics GRE exam at the end of the quarter.

<table>
<thead>
<tr>
<th>Year</th>
<th>Average score</th>
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<td>2006</td>
<td>710</td>
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<tr>
<td>2007</td>
<td>524</td>
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Our testing methods have been inconsistent, and we will try to standardize these for 2008.
## Appendix I - Annual Reports
### Department Statistics

#### A. Students

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<th></th>
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<td>2002</td>
<td>2003</td>
<td>2004</td>
<td>2005</td>
<td>2006</td>
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<td>1. Undergraduate</td>
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<td>29</td>
<td>19</td>
<td>18</td>
<td>22</td>
<td>22</td>
</tr>
<tr>
<td>2. Graduate</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>3</td>
<td>1</td>
<td>0</td>
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<tr>
<td>3. Total Number of Majors</td>
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<td>30</td>
<td>19</td>
<td>21</td>
<td>23</td>
<td>22</td>
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<tr>
<td>4. FTES Generated</td>
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#### B. Degrees Awarded

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<td>03-04</td>
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<td>2. Graduate</td>
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<td>3. Total</td>
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<td>4</td>
<td>5</td>
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#### C. Faculty

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<td>2006</td>
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<td>1. Full-Time</td>
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<td>4</td>
<td>3</td>
</tr>
<tr>
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<tr>
<td>Lecturer Headcount</td>
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<td>4. Full-Time</td>
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<tr>
<td>5. Part-Time</td>
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<td>6</td>
<td>3</td>
<td>3</td>
<td>2</td>
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<td>6. Total Non-Tenure Track</td>
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<td>3</td>
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<td>7. Grand Total All Faculty</td>
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<td>7</td>
<td>6</td>
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<td>7</td>
</tr>
<tr>
<td>Instructional FTE Faculty</td>
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<tr>
<td>8. Tenured/Track</td>
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<td>1.6</td>
<td>3.5</td>
<td>2.6</td>
<td>4.1</td>
<td>3.5</td>
</tr>
<tr>
<td>9. Lecturer</td>
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<td>1.9</td>
<td>1.6</td>
<td>1.4</td>
<td>1.7</td>
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<tr>
<td>10. Total Instructional FTEF</td>
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<td>5.2</td>
<td>5.4</td>
<td>4.2</td>
<td>5.5</td>
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<tr>
<td>Lecturer Teaching</td>
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<tr>
<td>11. % Lecturer/Total Instructional FT</td>
<td>71.9%</td>
<td>69.2%</td>
<td>35.2%</td>
<td>38.1%</td>
<td>25.5%</td>
<td>32.4%</td>
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<tr>
<td>12. FTES Taught by Lecturer</td>
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<td>46.1</td>
<td>49.1</td>
<td>27.6</td>
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<td>13. % FTES Lecture/FTES Generated</td>
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<td>79.1%</td>
<td>43.1%</td>
<td>51.2%</td>
<td>30.3%</td>
<td>42.8%</td>
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</table>

#### D. Student Faculty Ratios

<table>
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<th></th>
<th></th>
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<td>2003</td>
<td>2004</td>
<td>2005</td>
<td>2006</td>
</tr>
<tr>
<td>1. Tenured/Track</td>
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<td>17.4</td>
<td>18.0</td>
<td>15.5</td>
<td>18.4</td>
</tr>
<tr>
<td>2. Lecturer</td>
<td>18.1</td>
<td>25.6</td>
<td>24.3</td>
<td>30.7</td>
<td>19.7</td>
<td>28.6</td>
</tr>
<tr>
<td>3. SFR By Level (All Faculty)</td>
<td>17.5</td>
<td>22.4</td>
<td>19.8</td>
<td>22.8</td>
<td>16.6</td>
<td>21.7</td>
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<tr>
<td>4. Lower Division</td>
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<td>26.1</td>
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<td>5. Upper Division</td>
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<td>17.8</td>
<td>11.7</td>
<td>8.8</td>
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<td>6. Graduate</td>
<td>0</td>
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Appendix I - Annual Reports

Self Study

Since our last annual report the department of physics has made substantial changes in its general education course offerings, has developed a new minor, strengthened its undergraduate research activities, and has conducted a tenure track search. Below these activities are outlined along with plans for the next year.

In the spring of 2006 the general education program called for proposals for new and revised cluster sequences as part of its first year learning communities. The department submitted four proposals, all of which were accepted. *Atoms are Everything* is a new cluster sequence built around PHYS 1001,2,3 that allows students to take our physics sequence as freshman. Previously the only cluster available to physics majors was based on chemistry which resulted in many students waiting until their sophomore year to take physics. *Beats, Physics, and the Mind* is another new cluster that combines courses in music, physics, and philosophy. The physics department contribution to this cluster is a new course, PHYS 1200 *Behind the Music*, which is also being offered outside of the cluster program. *Energy and the Environment* is an old cluster that has been renovated and now consists of courses in physics, geology, and philosophy. Finally we resubmitted our *How Things Work* cluster with biology and geology that is essentially unchanged. Additional changes in our GE offerings has been to offer PHYS 3700, an upper division GE course, during the spring quarter and also more recently on the Concord campus. This class has been very successful, and we will continue to offer it quarterly on both campuses. Finally, we have tried offering a new upper division GE course, PHYS 3750, which has struggled to gain a critical enrollment. Next year we plan to offer this course in an online format.

The department has also revised its minor during the past year. Our previous minor was rather comprehensive and did not offer much flexibility to students. Additionally its unit requirement was on par with most masters degrees. Most importantly it was not attracting students. The new minor has a significantly reduced unit requirement and allows students much more freedom in choosing their courses.

One of the major activities that the faculty undertook this past year was a search for a new tenure track assistant professor. We had over 160 applicants and many very good candidates. After careful review the faculty selected Dr. Eric Helgren who accepted the position. Dr. Helgren is currently a staff scientist at UC Berkeley and does research in solid state physics and material science. Dr. Helgren will increase our full time TT faculty by 33%, and we are looking forward to his contributions in teaching, research, and department activities.

This past year the department has seen a significant increase in the number of undergraduates participating in research projects. Last year Dr. Kimball was awarded a $250,000 NSF equipment grant. He has made significant progress during the past year in using these funds to outfit his laboratory. Several students have been active in this process. In the fall students in his group presented research at a professional conference in Berkeley, and in the winter students traveled to Santa Barbra to present their work at another conference. It is our expectation that these types of opportunities for students will increase with Dr. Helgren joining the department.

Looking to the future there are a couple of areas where we plan on considering making changes to our programs. First of all we will consider a proposal for an option within the physics BA specifically for students that plan on teaching high school physics. This option would be a part of the University’s greater effort to train more math and science teachers. We will also consider creating either an option or new major in engineering physics. This program would be aimed at students looking for a more applied degree that still includes a foundational education in physics. Finally, the faculty will review the changes made to our physics program that started
Appendix I - Annual Reports

In 2005. One specific area of concern is the student and faculty workload associated with our 3 unit upper division courses. These courses were created to allow us to broaden our major without adding too many units. However, student and faculty have complained that the workload of these classes is nearly the same as 4 unit courses, while the compensation is not.

Assessment Plan

The department of physics has adopted an assessment plan that includes learning objectives and learning outcomes. Below the three learning outcomes are given along with a brief summary of the data collected for these during the past year.

1) Students will have a general understanding of the fundamental principles of physics.

In our introductory physics sequence (PHYS 1001,2,3) we measure this outcome with pre- and post-tests. Students are given a qualitative exam on the first day of class of each quarter covering several core ideas. The same exam is given to the students on the last day of the quarter. On average the percentage of students answering each question correctly increases by about 20%. In 2006 we identified several areas from these exams where improvement was minimal. We emphasized these concepts more heavily in 2007 and in most cases saw a more substantial improvement. Unfortunately there were also declines in other areas when comparing 2006 to 2007, indicating there is some trade-off. This is perhaps to be expected in a course so full of material. This emphasizes that it is important to decide what we want the students to learn, as it is extremely difficult to learn all of the material. Furthermore, this data indicates that instruction does make a difference in student learning.

2) Students should be able to effectively perform a physics experiment, analyze the acquired data, draw meaningful conclusions, and communicate these results to their peers.

We have adopted a rubric for evaluating this learning outcome. It has been applied for the first time this past fall in PHYS 3281.

3) Students have in-depth knowledge of the foundational subjects in physics (primarily analytical mechanics, quantum mechanics, thermodynamics and statistical mechanics, and electrodynamics).

Students enrolled in our capstone class, PHYS 4950 were given a physics GRE exam at the end of the quarter.

<table>
<thead>
<tr>
<th>Year</th>
<th>Average Score</th>
</tr>
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<tbody>
<tr>
<td>2006</td>
<td>710</td>
</tr>
<tr>
<td>2007</td>
<td>524</td>
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Our testing methods have been inconsistent, and we will try to standardize these for 2008.
# Appendix I - Annual Reports
## Department Statistics

### A. Students

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### D. Student Faculty Ratios

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<td>3. SFR By Level (All Faculty)</td>
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<td>4. Lower Division</td>
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<td>6. Graduate</td>
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<tr>
<td>7. Number of Sections Offered</td>
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</tr>
<tr>
<td>8. Average Section Size</td>
<td>20</td>
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</tbody>
</table>
Appendix I - Annual Reports

Self Study

The department of physics experienced several changes this year in its faculty, curriculum, and research activities. Dr. Erik Helgren joined the department from UC Berkeley. Dr. Helgren is a solid state physicist and has begun setting up a research laboratory around solar cell development. This year he taught several upper division majors courses as well as lower division service courses and did an outstanding job. He is a much needed addition to the department and has had a significant impact already. Sadly, the department of physics lost a long time member of its faculty, Dr. Robert Good, this year. Dr. Good who was the senior member of the department and had been at CSUEB since the 60’s passed away this past summer. This puts the department back down to four TT faculty, one associate professor and three assistant professors and once again we have a strong need for another faculty member. This past year less than half of our classes were taught by a TT faculty member, and even over a five year average we still need at least one hire to get to a 75% ratio of classes taught by TT faculty. Next year we will request a search for 2010-2011.

This past year we made several modifications to our program and course offerings to better serve our students. We created an option in physics education, designed specifically for students interested in teaching high school physics. This option will allow a student to earn a BA and simultaneously demonstrate subject matter competency by completing a CCTC approved subject matter program. We have also redesigned our introductory physics sequence, adding a fourth quarter. This will put us more in line with the vast majority of colleges and universities who spend at least a year and a half on this critical introductory sequence. Looking to next year we plan on making minor modifications to the physics BA and BS degree and will investigate creating an option in engineering physics.

In addition to the above changes orientated at physics majors, we have also added to our general education curriculum. In response to the high demand for upper division science GE courses we have created to new classes: Solar System Astronomy (PHYS 3710) and Stars and Galaxies (PHYS 3720). These will be offered for the first time in 2009-2010. This year we also moved another one of our upper division GE courses (PHYS 3750) to an online format. This allowed us to incorporate this course into the PACE program this year. The instructor for this course, Dr. Louis Villanueva, was awarded the instructor of the year by the PACE program.

The department has continued to emphasize undergraduate research over the past year, and in fact has been able to involve more students in research than ever before. Dr. Kimball has had ten undergraduates working in his laboratory this year. One of these students gave a talk at a regional conference and two others gave talks at international conferences. Dr. Kimball is entering his third year of a three year NSF equipment grant. He will be applying to renew this grant and is also taking the lead on a major instrumentation grant that is a collaboration between the departments of physics and chemistry. While still modest, the start-up package that we were able to offer Dr. Helgren was the largest in the history of the department and has allowed him to build a functional material science laboratory. This has broadened the available opportunities for our students interested in doing research. During his first year he has been able to involve four different students in his research activities. We expect that as he is able to further build up his laboratory even more students will have the opportunity to participate in a diverse range of research activities in the physics department.
Appendix I - Annual Reports
Assessment Plan

The department of physics has adopted an assessment plan that includes learning objectives and learning outcomes. Below the three learning outcomes are given along with a brief summary of the data collected for these during the past year.

1) **Students will have a general understanding of the fundamental principles of physics.**

   In our introductory physics sequence (PHYS 1001,2,3) we measure this outcome with pre- and post-tests. Students are given a qualitative exam on the first day of class of each quarter covering several core ideas. The same exam is given to the students on the last day of the quarter. We continue to see strong improvement in the students understanding after they have taken the course.

2) **Students should be able to effectively perform a physics experiment, analyze the acquired data, draw meaningful conclusions, and communicate these results to their peers.**

   We have adopted several rubrics for assessing different aspects of this learning outcome. These are applied in our upper division physics laboratories: PHYS 3281 Experimental Physics and PHYS 3283 Advanced Laboratory. As one example, in assessing students’ communication skills we have them give a presentation on one of their experiments near the beginning and at the end of the course. Using a standard rubric the students improved by an average of 9% during the course. Similar gains are observed in their ability to effectively perform a physics experiment, analyze the acquired data, and draw meaningful conclusions.

3) **Students have in-depth knowledge of the foundational subjects in physics (primarily analytical mechanics, quantum mechanics, thermodynamics and statistical mechanics, and electrodynamics).**

   Students enrolled in our capstone class, PHYS 4950 were given a physics GRE exam at the end of the quarter.

<table>
<thead>
<tr>
<th>Year</th>
<th>Average Score</th>
</tr>
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<tbody>
<tr>
<td>2006</td>
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<tr>
<td>2008</td>
<td></td>
</tr>
<tr>
<td>2009</td>
<td>605</td>
</tr>
</tbody>
</table>
Self Study

The department of physics has worked to continue to find new ways to better serve our students, even during these tough economic times. Some new projects were implemented this year, while others were postponed due to budget constraints. The department continued to see strong growth in our courses, continuing a trend of the past few years. This growth has led to a greater reliance on part-time lectures. As of fall 2008, 39% of our FTEF were lectures, and this proportion has only grown in the past year. The department is in need of another tenure track position to handle the growth of the past several years.

Curriculum

This year the department’s new option in physics education was approved by the academic senate. This option is designed for students interested in teaching high school physics. The option was developed in tandem with other department in the college as part of the University’s comprehensive effort to recruit and train more students to become secondary school science teachers. The department chair also attended a regional conference organized by the American Physical Society with the aim to develop inter-campus efforts to recruit physics majors into teaching careers.

The department offered one of two new upper division general education courses that were approved last year. The class had a fair enrollment in the fall, but the enrollment was too small in the winter and it had to be cancelled. Another existing upper division general education course offered on the Concord campus also had to be cancelled for the spring quarter due to low enrollment. On the other hand, our upper division GE class, PHYS 3700, has had enrollments of close to 100 all year, and our new online Biophysics class has also filled beyond the cap this spring.

A project that we were not able to institute this year was the expansion of our lower division physics sequence to four quarters. Nearly all colleges and universities offer at least a year and a half for this sequence, so we created a new course last year to give us more time to teach the introductory physics sequence. Unfortunately, the severe budget crisis has not allowed us to offer this course and will most likely force us to postpone it yet again next year. The mathematics department has been able to add a fourth quarter of calculus, and we will need to examine how we can include this course in our degree requirements next year.

Faculty

It was a very good year for our faculty and their professional activities. Dr. Singley is in the second year of his $285k Community College Transfer Project grant, and was also awarded $125k as part of the Math and Science Teacher Initiative this year. Dr. Kimball had his $250k NSF Spin Gravity research grant renewed for three more years. Dr. Helgren, Dr. Kimball, and Dr. Singley along with Dr. Maisello from chemistry were awarded a $393k NSF MRI grant to purchase and set up a dual use frequency comb - THz spectrometer based on an ultrafast femtosecond laser. Dr. Helgren, in his second year on campus has made outstanding progress at setting up his research lab and was recently profiled in the quarterly campus magazine. All of these activities provide extraordinary opportunities for our students to receive the training they need to be successful in their careers.
The department of physics continues to implement its assessment plan. This plan is based on the three learning outcomes shown below. A summary of the data collected for each of these outcomes is given below.

1) Students will have a general understanding of the fundamental principles of physics.

For the past couple of years we have been measuring this outcome in our introductory physics sequence (PHYS 1001, 2, 3) for physics, engineering and chemistry majors. This is accomplished with pre- and post-tests. Students are given a qualitative exam on the first day of class of each quarter covering several core ideas. The same exam is given to the students on the last day of the quarter. This year we have expanded this pre- and post test to our introductory physics sequence for life science majors. We continue to see strong improvement in the students understanding after they have taken these courses.

2) Students should be able to effectively perform a physics experiment, analyze the acquired data, draw meaningful conclusions, and communicate these results to their peers.

We continue to measure this learning outcome in our upper division physics laboratories: PHYS 3281 Experimental Physics and PHYS 3283 Advanced Laboratory. The department has a standardized rubric for which we evaluate student’s abilities to communicate scientific ideas.

3) Students have in-depth knowledge of the foundational subjects in physics (primarily analytical mechanics, quantum mechanics, thermodynamics and statistical mechanics, and electrodynamics).

Students enrolled in our capstone class, PHYS 4950 were given a physics GRE exam at the end of the quarter.

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## Appendix I - Annual Reports
### Institutional Data

### Physics

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#### College Years

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#### Fall Quarter

##### C. Faculty

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#### Instructional FTE Faculty

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##### Lecturer Teaching

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<td>7. Number of Sections Offered</td>
<td>23</td>
<td>27</td>
<td>26</td>
<td>31</td>
<td>26</td>
</tr>
<tr>
<td>8. Average Section Size</td>
<td>27</td>
<td>23</td>
<td>25</td>
<td>24</td>
<td>26</td>
</tr>
</tbody>
</table>

Source and definitions available at: [http://www.csueastbay.edu/ira/apr/summary/definitions.pdf](http://www.csueastbay.edu/ira/apr/summary/definitions.pdf)