**COMMITTEE ON ACADEMIC PLANNING AND REVIEW**
**ANNUAL PROGRAM REPORT**

| | |
|---|---|
| College | CoS |
| Department | Physics |
| Program Unit | |
| Reporting for Academic Year | 2015-2016 |
| Department Chair | Erik B. Helgren |
| Date Submitted | 8/26/2016 |

## 1. SELF-STUDY (about 1 page)

### A. Five-year Review Planning Goals

The last Five-year review occurred in the 2010-11 academic year. The planning goals set forth at that time were:

1. Add Physics 2004 (Modern Physics) to Physics Major/Minor curriculum.
2. Modify Physics Major Mathematics Requirement: add Math 2305 (Calculus IV) and remove Math 4361 (Partial Differential Equations).
3. Capstone projects/class for Physics Majors.
4. Develop Seminar course.
5. Develop Engineering Physics Major.
6. Continue strong General Education offerings.
7. Review/re-design learning objectives and assessment.
8. Maintain a high quality, rigorous offering of physics classes.
9. Provide undergraduate research experiences for all interested majors.
10. Develop and implement a marketing plan for student recruitment.
11. Add TT faculty with specialty in Atomic Physics.
12. Invest in upgraded laboratory equipment for teaching and research.

Note: the next five-year review shall be pushed back due to the Quarter to Semester planning process and a specific date will be determined by CAPR during the 2016-17 academic year.

### B. Five-year Review Planning Goals Progress

1. Physics 2004 – “Modern Physics,” a fourth quarter of the Introductory Physics curriculum has been successfully introduced to the Physics major and taught from 2011-present, and has been both popular and successful in better preparing majors for upper division physics. The course has also become popular for transfer students who voluntarily enroll in the course to learn the skills and tools we teach in the class which better prepare students for their upper division coursework.

The class is always offered in the Fall quarter.

2. The changes to the Math requirements for the Major have been made; adding Math 2305 (Calculus IV) and dropping Math 4361 (Partial Differential Equations).

3. After review of the feasibility of the Capstone projects/course, we have decided to maintain our current Physics 4950 (Capstone) curriculum and allow individual students to complete “capstone-like” projects with faculty members as part of their informal research activities. The Physics 4950 Capstone class now plays a critical role in our summative assessment of physics majors, so we have decided not to re-design it into a project class. The concept of a Capstone project however was popular amongst the faculty and a summative capstone project will be included in our new two-year lab experience for Physics majors under the semester system.

4. We have secured a $100k endowment for our Seminar series and have maintained a strong level of outside speakers for the Seminars, but have decided not to pursue conversion of the series into a course, in part due to the restrictions faced by the Department in regards to the major unit caps. The Spitzer Memorial Lecture Series has been significantly expanded over the past four years and has been a core part of our Physics Department culture for faculty and students. However, we have decided not to pursue conversion of the series into a course, in part due to the restrictions faced by the Department in regards to the 180 unit cap for all majors.

5. Instead of developing an Engineering Physics major, we have significantly revised the Physics BA and Physics Education BA, to facilitate attracting majors who are “late deciders” or those wanting to double major. Prof. Erik Helgren has developed, with the aid of a Chancellor’s Office Campus as a Living Lab grant, an engineering-focused Advanced Experimental Laboratory course to accommodate students from the Engineering Department. Furthermore, we have worked in conjunction with the Engineering Faculty to offer more sections of Physics 3280 (Electronics), which is now a requirement for the Computer Engineering degree.

6. Our General Education course offerings have continued to have strong enrollment, and we have significantly upgraded our Physics 1800 and 1880 (Astronomy) courses and Physics 1700 and 1780 (Elementary Physics) courses. For instance, in the 2015-16 academic year, Dr. Amy Furniss, a new faculty member in the department whose research focus is on Astrophysics, developed new teaching modules for both the on-ground and online versions of the PHYS 1800 Astronomy courses connecting her research to class topics. We have developed two new First Year Learning Community courses (PHYS 1810: Astronomy of Ancient Cultures and PHYS 1410: Physics for Future Leaders).

7. We carried out a comprehensive review of our learning outcomes and assessment in the 2012-13 academic year and developed new learning outcomes and a number of new assessment tools. Full implementation of our assessment plan was carried out from 2013-16, and the included assessment report summarizes this year’s results.

8. We have been able to maintain the rigorous nature and high quality of our Physics Major curriculum. This is validated by the fact that a greater number of our Physics majors are successfully entering graduate programs in the field (as compared to the annual average in the previous 5-year review period) and a number of our recent graduates have been awarded the prestigious National Science Foundation Graduate Research Fellowship (Trinity Joshi nee Pradhananga at UC Berkeley in 2013, Jerlyn Swiatlowski at UC Riverside in 2015 and Jordan Dudley at UC Berkeley in 2016).

9. All interested undergraduate physics majors have been able to be involved in meaningful research projects with faculty, several leading to regional/national conference presentations and publications in peer-reviewed journals. Students have provided feedback that the participation in undergraduate research has led to successful internships at local national labs and in industry.

10. Annually we continue to work with university partners to create a list of incoming freshmen who have passed the ELM at a high level and were undeclared. Our department contacts these individuals in the summer/early Fall timeframe in order to promote the Physics major. We will continue our recruitment plan, and will implement a re-design of our Department website, during 2016-17. Our new Physics Department Office Manager, Ms. Jacqueline Adams (hired in summer 2016) will be facilitating our renewed marketing efforts.

11. Dr. Jennie Guzman was hired in Fall 2013, specializing in Atomic Physics experiments involving ultracold atoms. We hired two new faculty who started in Fall 2015. Dr. Amy Furniss specializes in Astrophysics research and is a member of the world-renowned VERITAS program. She earned her undergraduate degree in Physics at Humboldt State University and has now returned home to the CSU system. Dr. Ryan Smith specializes in using ultra-fast laser spectroscopy tools to study renewable energy materials. Dr. Smith, who was hired under the new Affinity Hire program, will be joining us from CSU Maritime where he has taught for the last few years. With the promotion of Dr. Jason Singley to Dean of the College of Science, our department lost an excellent and dedicated faculty member, however our department will be carrying out a faculty search during the 2016-17 academic year to bring a new faculty member on board starting in the Fall of 2017. Our research capacity is at an all-time high in terms of breadth and quality. Significant external research funds have been secured by faculty in the form of both CSU grants, National Science Foundation, and private foundation grants. As part of the efforts of the College of Science Space Committee, we have secured new space for our Department in order to expand our faculty research.

12. With both significant investments from A2E2 and funds raised through teaching self-support courses, we have made major upgrades to laboratory equipment for teaching and research.

## C. Program Changes and Needs

We believe that the Department has successfully achieved all of its goals as identified in the previous Five-Year Review, and has laid the groundwork for continued success.

Significant changes to our program have been planned as a result of the quarter-to-semester conversion. The lower division introductory coursework (PHYS 135, 136 and 137) was transformed from four five-unit quarter courses into the three four-unit semester courses. One of the over-arching themes in our transformed major is that the curriculum now includes more hands-on laboratory coursework and we have transformed the labs to include more high impact practice and a focus on developing laboratory skills. For instance, the labs accompanying the lower division introductory coursework were transformed to include inquiry-based learning methodologies and a focus on mastery of important lab-skills (e.g., ability to design an experiment, record, analyze and plot data and apply appropriate error analysis methods) by the end of the sequence.

In the upper division, a Physics B.S. major will continuously be enrolled in an upper division lab, i.e., we have a four-semester sequence of advanced labs that native students start taking in their junior year and transfer students as soon as they arrive. The upper division labs will allow students to develop mastery in electronics, and various "tracks" or areas of interest that students decide upon, e.g., optics, sustainability, solid state Physics, Atomic Physics, Astrophysics, etc. Physics B.S. majors will learn sound scientific practices and the four semester sequence will provide scaffolded integration of project-based learning.

We have also decided to place a strong emphasis on "Writing across the curriculum." We have transformed our major to include a second semester, sophomore year course (to be taken upon completion of the three semester introductory Physics sequence) PHYS 230 – Physical Reasoning. This course will focus on the elements of sound physical reasoning as expressed through clear scientific writing. Students will write detailed solutions to challenging problems, summaries of research articles, and reviews of important topics of physics. Students will be introduced to techniques to solve non-analytic problems, i.e. computational methods. We expect that this course will satisfy the Writing II/Writing-in-the-Discipline University requirement.

The Physics program will also now include a wider array of elective courses (AMO, Condensed Matter, Particle and Astrophysics) compared to under the quarter system as the department faculty's areas of expertise now covers the latter two areas.

Ongoing efforts addressed in the 5-year review plan:

(a) Curriculum: In order to continue our progress toward meeting our Five-Year Review Planning Goals, during the 2016-17 academic year we will focus on (1) continuing to implement our multi-year Assessment Plan (Goal #7) and (2) continue to address marketing and recruitment needs for our department which will include implementing our re-designed Department website (Goal #10).

(b) Resources: Our most pressing needs are for office and laboratory space for our new tenure-track faculty members, office space for our lecturers, and lecture and laboratory classroom space for our classes. The College of Science formed a space committee/taskforce during the 2015-16 academic year to address redistribution/re-allocation of non-teaching space for the departments in the College of Science. Through this process our department made headway in the office and lab space problems, however, we are still encountering problems scheduling classes and labs in the face of ever-increasing student enrollment and demand for our department's major, GE and "service courses".

## 2. SUMMARY OF ASSESSMENT (about 1 page)

### A. Program Student Learning Outcomes

Students graduating with a degree in Physics will be able to:

A. Understand the fundamental principles of physics and be able to apply these core ideas to analyze physical processes;

B. Apply quantitative reasoning and critical thinking to solve complex problems, both theoretical and experimental in nature;

C. Independently learn new technical subjects and skills;

D. Design and assemble experiments, quantitatively analyze the results using appropriate statistical procedures and tests of systematic errors, and draw meaningful conclusions;

E. Effectively communicate scientific ideas, both theoretical and experimental, to diverse audiences through written and oral presentations, both formal and informal;

F. Work effectively and inclusively as a member of diverse collaborations to solve problems.

(curriculum map showing alignment of the Program Student Learning Outcomes and CSUEB Institutional Learning Outcomes is attached)

### B. Program Student Learning Outcome(s) Assessed

SLOs 1, 2, and 3 were assessed.

### C. Summary of Assessment Process

See attached Assessment Report.

### D. Summary of Assessment Results

See attached Assessment Report.

## 3. STATISTICAL DATA (about 1 page)

# California State University, East Bay

**APR Summary Data**

**Fall 2011 - 2015**

| **Physics** | **Fall Quarter** | | | | |
|---|---|---|---|---|---|
| | **2011** | **2012** | **2013** | **2014** | **2015** |
| ***A. Students Headcount*** | | | | | |
| 1. Undergraduate | 28 | 31 | 31 | 30 | 25 |
| 2. Postbaccalaureate | 1 | 0 | 0 | 0 | 0 |
| 3. Graduate | 0 | 0 | 0 | 0 | 0 |
| 4. Total Number of Majors | 29 | 31 | 31 | 30 | 25 |
| | **College Years** | | | | |
| ***B. Degrees Awarded*** | **10-11** | **11-12** | **12-13** | **13-14** | **14-15** |
| 1. Undergraduate | 4 | 2 | 4 | 6 | 5 |
| 2. Graduate | 0 | 0 | 0 | 0 | 0 |
| 3. Total | 4 | 2 | 4 | 6 | 5 |
| | **Fall Quarter** | | | | |
| | **2011** | **2012** | **2013** | **2014** | **2015** |
| ***C. Faculty*** | | | | | |
| **Tenured/Track Headcount** | | | | | |
| 1. Full-Time | 4 | 4 | 5 | 4 | 5 |
| 2. Part-Time | 0 | 0 | 0 | 0 | 0 |
| 3a. Total Tenure Track | 4 | 4 | 5 | 4 | 5 |
| 3b. % Tenure Track | 40.0% | 40.0% | 33.3% | 23.5% | 31.3% |
| **Lecturer Headcount** | | | | | |
| 4. Full-Time | 0 | 0 | 1 | 0 | 0 |
| 5. Part-Time | 6 | 6 | 9 | 13 | 11 |
| 6a. Total Non-Tenure Track | 6 | 6 | 10 | 13 | 11 |
| 6b. % Non-Tenure Track | 60.0% | 60.0% | 66.7% | 76.5% | 68.8% |
| 7. Grand Total All Faculty | 10 | 10 | 15 | 17 | 16 |
| **Instructional FTE Faculty (FTEF)** | | | | | |
| 8. Tenured/Track FTEF | 3.3 | 2.8 | 2.4 | 2.9 | 3.6 |
| 9. Lecturer FTEF | 3.1 | 3.4 | 4.9 | 4.8 | 5.3 |
| 10. Total Instructional FTEF | 6.3 | 6.2 | 7.4 | 7.7 | 8.9 |
| **Lecturer Teaching** | | | | | |
| 11a. FTES Taught by Tenure/Track | 77.9 | 90.0 | 53.3 | 56.0 | 38.9 |
| 11b. % of FTES Taught by Tenure/Track | 46.1% | 42.1% | 23.5% | 26.5% | 16.6% |
| 12a. FTES Taught by Lecturer | 91.0 | 123.9 | 173.4 | 155.4 | 195.8 |
| 12b. % of FTES Taught by Lecturer | 53.9% | 57.9% | 76.5% | 73.5% | 83.4% |
| 13. Total FTES taught | 168.9 | 213.9 | 226.7 | 211.4 | 234.7 |
| 14. Total SCU taught | 2534.0 | 3209.0 | 3401.0 | 3170.5 | 3520.0 |
| ***D. Student Faculty Ratios*** | | | | | |
| 1. Tenured/Track | 23.8 | 32.4 | 22.1 | 19.2 | 10.9 |
| 2. Lecturer | 29.7 | 36.4 | 35.1 | 32.3 | 36.7 |

| | | | | | |
|---|---|---|---|---|---|
| 3. SFR By Level (All Faculty) | 26.7 | 34.6 | 30.8 | 27.4 | 26.4 |
| 4. Lower Division | 25.4 | 34.0 | 27.6 | 26.8 | 25.7 |
| 5. Upper Division | 31.7 | 36.7 | 41.9 | 29.1 | 28.0 |
| 6. Graduate | . | . | . | . | . |
| ***E. Section Size*** | | | | | |
| 1. Number of Sections Offered | 40.0 | 39.0 | 44.0 | 44.0 | 41.0 |
| 2. Average Section Size | 28.4 | 33.7 | 30.9 | 29.9 | 32.0 |
| 3. Average Section Size for LD | 28.2 | 33.7 | 28.5 | 29.1 | 31.5 |
| 4. Average Section Size for UD | 29.6 | 34.0 | 44.5 | 34.7 | 33.8 |
| 5. Average Section Size for GD | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 6. LD Section taught by Tenured/Track | 15 | 13 | 9 | 8 | 4 |
| 7. UD Section taught by Tenured/Track | 5 | 5 | 7 | 6 | 7 |
| 8. GD Section taught by Tenured/Track | 0 | 0 | 0 | 0 | 0 |
| 9. LD Section taught by Lecturer | 16 | 16 | 24 | 25 | 27 |
| 10. UD Section taught by Lecturer | 4 | 5 | 4 | 5 | 3 |
| 11. GD Section taught by Lecturer | 0 | 0 | 0 | 0 | 0 |

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

## *DEPARTMENT OF PHYSICS 2015-16 ASSESSMENT REPORT*

### PHYSICS MAJOR LEARNING OBJECTIVES

Throughout the 2015-16 Academic Year, the Department of Physics had numerous meetings to develop the new semester curriculum, and in many of the meetings significant discussion of assessment results was carried out and our assessment activities informed curriculum development for the new Physics BS, BA, Minor, and Astrophysics Minor. Continued focus was placed on our Physics Major Learning Objectives.

Students graduating with a degree in Physics will be able to:

A. Understand the fundamental principles of physics and be able to apply these core ideas to analyze physical processes;
B. Apply quantitative reasoning and critical thinking to solve complex problems, both theoretical and experimental in nature;
C. Independently learn new technical subjects and skills;
D. Design, **construct**, **assess** and **troubleshoot** experiments, quantitatively analyze the results using appropriate statistical procedures and tests of systematic errors, and draw meaningful conclusions;
E. Effectively communicate scientific ideas, both theoretical and experimental, to diverse audiences through written and oral presentations, both formal and informal;
F. Work **professionally**, effectively, and inclusively as a member of diverse collaborations to solve problems.

### RESULTS

**<u>Pre- and post-instruction tests/surveys</u>: (SLOs: A,B,C)**

These exams give us a snapshot of the students' working knowledge in physics, conceptual understanding, and ability to efficiently solve problems. These exams are a core part of our assessment of our first three SLOs. Since the tests are nationally normed they enable us to make quantitative comparisons of our students' performance to that of students from other institutions.

A subset of the exams are given before and after instruction (at the beginning of the course and at the conclusion of the course) to provide a quantitative measure of student improvement during the course. The gain is calculated as the difference between pre- and post-instruction scores divided by the number of incorrect answers on the pre-test.

**1. Physics 1001 (Force Concept Inventory, FCI, a nationally normed assessment tool)**

The Force Concept Inventory (FCI) instrument is designed to assess student understanding of the most basic concepts in Newtonian physics. This forced-choice instrument has 30 questions and looks at six areas of understanding: kinematics, Newton's First, Second, and Third Laws, the superposition principle, and types of forces (such as gravitation, friction). Each question offers only one correct Newtonian solution, with common-sense distractors (incorrect possible answers) that are based upon student's misconceptions about that topic, gained from interviews.

| | 2015 | 2014 | 2013 | 2012 | 2011 |
|---|---|---|---|---|---|
| Gain between post- and pre-test: | 45 | 56 | 27 | 30 | 31 |
| Overall post-test score: | 59 | 66 | 47 | 52 | 48 |

Studies have shown that in a traditional, well-taught lecture class, the FCI gain is measured to be around 20% while in a class employing a wide range of active engagement and peer-to-peer instruction techniques, the FCI gain can approach close to 50%.

For the overall post-test FCI score, the generally acknowledged threshold for understanding the material is an average of about 60%.

In 2015, the General Physics students were able to achieve an FCI gain of 45% and a post-test average 59%, indicating successful learning compared to national averages. Some relevant factors that have persisted between the relatively successful 2014 and 2015 versions of the course may have been the frequent use of peer-to-peer instruction activities (such as think-pair-share), implementation of weekly quizzes and reviews, and a reduction of material covered in order to focus more classroom time on core subjects.

**2. Physics 1003 (Brief E&M Assessment, BEMA, a nationally normed assessment tool)**

The Brief Electricity and Magnetism Assessment (BEMA) assesses what students know about the most basic and central concepts of the calculus-based introductory E&M course. It is comprehensive, covering topics from the Coulomb force law to magnetic induction, but omitting radiation because it is very common for the introductory course not to get that far. It has been used by various instructors in various settings and has been judged an appropriate and fair assessment of introductory E&M by physicists experienced in teaching E&M at various levels. It is not aimed at any particular curriculum but contains only those elements common to all calculus-based introductory courses.

| | 2015 | 2014 | 2013 |
|---|---|---|---|
| Gain between post- and pre-test: | 22 | 14 | 29 |
| Overall post-test score: | 42 | 37 | 47 |

Studies have shown that in a traditional, well-taught lecture class, the BEMA gain is measured to be around 20% while in a class employing a wide range of active engagement and peer-to-peer instruction techniques, the gain can be above 30%.

For the overall post-test BEMA score, the generally acknowledged threshold for understanding the material is an average of about 60%.

Of significant concern is that our students are not meeting these thresholds. As part of our new curriculum, we have converted our 1 quarter electromagnetism course (PHYS 1003) into a 1 semester course (PHYS 136), covering the same material but with an extended time to include more active learning, peer-to-peer activities, and review and assessment throughout the course.

**3. Physics 4001-4003 (Brief E&M Assessment, BEMA, a nationally normed assessment tool)**

The BEMA was also used to assess upper division students' knowledge of electromagnetism in Physics 4001-4003. The exam was administered at the beginning of PHYS 4001 and again at the conclusion of PHYS 4003 with the results listed below:

| | 4001-4003 (3rd/4th yr) | 1003 (1st yr) |
|---|---|---|
| Gain between post- and pre-test: | 15 | 22 |
| Overall post-test score: | 45 | 42 |

Of significant concern, we did not observe significant gains between the lower and upper division performance. The Department has discussed this at length and continues to debate the best path forward. The introduction of the new PHYS 230 (Physical Reasoning) is intended to offer further review and reinforcement of basic concepts in electromagnetism and other subjects in Physics.

**4. Physics 2004 (Physics GRE-based assessment, Physics GRE-9277, nationally normed for students applying to graduate school)**

The Physics Graduate Record Exam (GRE) test consists of approximately 100 five-choice questions, some of which are grouped in sets and based on such materials as diagrams, graphs, experimental data and descriptions of physical situations. The aim of the test is to determine the extent of the examinees' grasp of fundamental principles and their ability to apply these principles in the solution of problems. Most test questions can be answered on the basis of a mastery of the first three years of undergraduate physics.

In Physics 2004, we use a subset of questions from the GRE test centered around topics that students should have familiarity with through the General Physics sequence (including Modern Physics, PHYS 2004).

*Subject area breakdown*:

| Subject | 2014 results | 2013 results | National Average |
|---|---|---|---|
| Classical mechanics: | 29 | 25 | 52 |
| Electromagnetism: | 11 | 18 | 48 |
| Optics: | 30 | 25 | 40 |
| Thermodynamics: | 18 | 19 | 52 |
| Quantum: | 25 | 18 | 45 |
| Special relativity: | 24 | 22 | 39 |
| Laboratory methods: | 23 | 19 | 39 |
| Special topics: | 9 | 38 | 39 |

Results were largely consistent from year-to-year.

**5. Physics 4950 (Physics GRE-0177, nationally normed for students applying to graduate school)**

The Physics Graduate Record Exam (GRE) test consists of approximately 100 five-choice questions, some of which are grouped in sets and based on such materials as diagrams, graphs, experimental data and descriptions of physical situations. The aim of the test is to determine the extent of the examinees' grasp of fundamental principles and their ability to apply these principles in the solution of problems. Most test questions can be answered on the basis of a mastery of the first three years of undergraduate physics.

In Physics 4950, our Capstone class, we use a complete GRE test covering all subjects in Physics.

*Subject area breakdown*:

| Subject | 2014 results | 2013 results | National average |
|---|---|---|---|
| Classical mechanics: | 20 | 24 | 51.6 |
| Electromagnetism: | 21 | 27 | 48.2 |
| Optics: | 15 | 20 | 39.8 |
| Thermodynamics: | 15 | 21 | 51.9 |
| Quantum: | 25 | 11 | 45.4 |
| Atomic: | 29 | 29 | 52.1 |
| Special relativity: | 0 | 9 | 38.8 |
| Laboratory methods: | 33 | 39 | 38.5 |
| Special topics: | 20 | 20 | 38.8 |

**6. Comparison of Physics 2004 (2nd year) to Physics 4950 (4th year) results:**

| Subject | Physics 2004 (avg) | Physics 4950 (avg) |
|---|---|---|
| Classical mechanics: | 27 | 22 |
| Electromagnetism: | 15 | 24 |
| Optics: | 28 | 18 |
| Thermodynamics: | 19 | 18 |
| Quantum: | 22 | 18 |
| Special relativity: | 23 | 5 |
| Laboratory methods: | 22 | 36 |
| Special topics: | 24 | 20 |

Of concern, here too we did not observe significant gains between the lower and upper division performance.

**Summary of assessment results from nationally normed exams:**

A Department goal is for our students to achieve at least the national average on all nationally normed exams. (This goal, in the case of the GRE exam, may be aspirational as we are comparing all our students to a subset of students who applied to graduate school in Physics.)

There are certainly some bright spots as we have achieved or have come close to achieving that goal for the Physics 1000 series, indicating that our General Physics instruction is successful and our teaching strategies are working.

However, the performance of our upper division students falls short of our goals, and in fact the performance of the 3rd and 4th-year students shows little improvement compared to the 1st and 2nd-year students. On the other hand, one should be careful about reading too much into the results as relatively few students (< 10) have taken the exams each year.

The Department held many meetings of the tenure-track faculty throughout the year to “close the loop” and strategize on what improvements might be made to curriculum and teaching methods.

It was the continued opinion of the faculty that based on these results, physics majors overall were suffering from a lack of a fund of knowledge about physics and had significant weaknesses in conceptual understanding and problem solving skills that needed to be addressed.

The following strategies were suggested:

(1) Basic physics knowledge taught in the General Physics sequence (PHYS 1001-1003, PHYS 2004) would continue to be emphasized throughout the upper-division curriculum by additional “basic” problems added on to homework assignments to give students extra practice at the basic concepts. This will be done, to as great a degree as possible, without sacrificing the advanced instruction that is part of the present curriculum.

(2) We have moved away from allowing note sheets on upper division exams to further emphasize learning and remembering physics concepts, relations, and problem solving strategies to improve students’ fund of physics knowledge. Weekly quizzes without notes and more in-class, peer-to-peer

activities are a useful tool for reinforcing basic knowledge and problem-solving skills that can be used in upper division as well as lower division courses.

(3) We will continue to increase use of in-class presentations of problem solutions and peer-to-peer learning strategies in upper division classes to further emphasize and practice accessing the fund of physics knowledge.

(4) We will emphasize throughout lower and upper division the “Prepare-Solve-Assess” strategy of problem solving.

(5) We will expand use of peer evaluation to help teach students how to evaluate their own work.

When converting to semesters, we are planning to offer three semesters of General Physics and a writing class, *PHYS 230: Physical Reasoning*, to further emphasize and review fundamental knowledge and problem solving skills.