

# Major Assessment Plan

## Bachelor of Science in Physics Bachelor of Science in Applied Physics

### School of Physics Georgia Institute of Technology

#### MISSION

Within the Georgia Tech mission of research, education, and public service, the mission of the School of Physics encompasses the following areas.

**Research:** To make leading contributions to basic and applied science by:

- conducting broadly based research in both theoretical and applied areas with emphases in: Acoustics, Particle Physics, Chaos, Chemical Physics, Statistical Mechanics, Optics/Laser Physics, Solid-State Physics, and Nano-technology;
- collaborating on interdisciplinary efforts with other units including Chemistry, Biochemistry, Electrical and Computer Engineering, and Mathematics; and by
- supporting research centers such as the Center for Computational Materials Science.

**Educational Programs:** To provide the next generation of leaders and capable lifelong learners in Physics and Applied Physics, The School of Physics offers programs at the baccalaureate, master's and doctoral levels.

**Service:** To serve the people of Georgia and the larger scientific community by participating in outreach activities such as the Faculty Development Program and the Teacher Certification Program. To support other programs at Georgia Tech by offering rigorous training in basic physics for non-majors.

#### PROGRAM PURPOSES AND PHILOSOPHY

The School of Physics offers two undergraduate degrees, the Bachelor of Science in Physics and the Bachelor of Science in Applied Physics. The basis of the former degree program is the traditional preparation of a student for graduate study in physics. The degree program in applied physics may be better suited for entry into industry or government upon graduation, preparation for further professional training, or preparation for graduate study in some other discipline. The two degree programs differ in that a few courses intended primarily as preparation for graduate study in physics in the traditional program are replaced by courses oriented toward the applications of physics in the applied physics program.

Each of the baccalaureate programs contains the following:

- a. courses needed to meet general institutional degree requirements;
- b. a core of technical courses intended to give strong background in mathematics and in the physical sciences of mechanics, electricity and magnetism, thermodynamics, and the quantum theory that governs physical phenomena at the microscopic level of molecules, atoms, and nuclei;
- c. technical electives that enable the student to explore areas of his or her choice in greater depth;
- d. free electives, about one-fifth of the total hours, which may be employed to schedule additional technical or non-technical courses, and
- e. a two-semester Senior Physics Seminar, required of all seniors (Phys 4601-02), which functions as an integrative experience and allows students to demonstrate acquisition and synthesis of the knowledge, skills, and abilities acquired through either baccalaureate program of study.

The science of physics represents an intellectual endeavor in understanding the fundamental nature of the universe in which we live. Such an understanding not only leads to direct practical consequences but also supports the other sciences, engineering disciplines, and various technical subjects. The study of physics and mathematics, which are intimately related, further provides a preparation for research and professional work in areas that require logic and practicality.

## **INTENDED LEARNING OBJECTIVES/OUTCOMES**

Below are expected competencies for physics majors. The first three are also included in the Institute's General Education Assessment Plan.

### **1. Communication**

Students will be able to communicate in both written and oral forms in such a way as to demonstrate their ability to present information clearly, logically, and critically

### **2. Science and Mathematics**

Students will demonstrate an understanding and application of scientific methodology, quantitative problem-solving, and experimental techniques.

### **3. Computer and Information Literacy**

Students will demonstrate effective use of computers and libraries, in concert with their overall studies.

### **4. Scientific Reasoning**

Students will demonstrate proficiency in analyzing and critiquing the development of physics ideas in published texts, reports, and research proceedings.

### **5. Knowledge of Core Physics and its Applications**

Students majoring in physics will understand principles of the primary areas of physics and will develop a facility for advanced study in chosen specialized areas.

### **6. Preparation for Careers and/or Graduate Study**

Students will be prepared for a career in a scientifically or technically oriented business or industry, or for graduate study in physics or other scientific or technical fields.

## **PROCEDURES, MEASURES AND CRITERIA**

### **1. Communication:**

Students will be able to communicate in written, oral and graphic forms in such a way as to demonstrate their ability to present information clearly, logically, and critically.

Evaluation procedure 1a: Student written reports of guest lectures from the capstone courses, Phys 4601-02, will demonstrate that 90% of students understand, can satisfactorily organize, and can critically evaluate the information presented. Students in capstone courses are also required to write reports as part of their project presentations. These reports will be read by two faculty members and evaluated for clarity of expression, organization, grammar, and use of language appropriate to Physics. A scoring rubric will be used, and scores will be compared between raters. 90% of students will meet the minimum standards established.

Evaluation procedure 1b: Student oral presentations of projects in the senior capstone sequence (Phys 4601-02) will be evaluated by faculty, peers, and outside observers for logical organization, mastery of content, and critical presentation of ideas. A scoring rubric will be used, and scores will be compared between raters. 90% of students will meet the minimum standards established.

Evaluation procedure 1c: One year after graduation, at least 90% of respondents to the GT undergraduate alumni survey will indicate they received "excellent" or "good" preparation in written, oral, and graphic communication skills.

Evaluation procedure 1d: One year after graduation, at least 90% of supervisors of alumni who respond to the GT employer survey will indicate that program graduates have "excellent" or "good" written, oral, and graphic communication skills. They will also indicate that at least 90% of program graduates display "excellent" or "good" abilities in presenting information in a clear, logical, and critical manner.

### **2. Science and Mathematics:**

Students will demonstrate an understanding and application of scientific methodology, quantitative problem-solving, and experimental techniques.

Evaluation procedure 2a: In the senior capstone sequence (Phys 4601-02), students will be encouraged to undertake an independent research project or to become involved in research projects within the School and

at National laboratories. Students are required to write reports as part of their project presentations in these courses. The reports will be read by two faculty members and evaluated for understanding of research methods, quantitative problem-solving skills, and experimental techniques. A scoring rubric will be used, and scores will be compared between raters. At least 90% of students will meet minimum standards for performance in this area.

Evaluation procedure 2b: As a required portion of the senior sequence, all graduating seniors will take the Physics subject test of the GRE and will be asked to report their results to Georgia Tech. This will provide the program with objective evidence of student knowledge relative to research methods, quantitative problem-solving skills, and understanding of experimental techniques. 90% of graduating seniors will score at or above the 85<sup>th</sup> percentile on the Physics subject test.

Evaluation procedure 2c: Problem-solving and methodological skills will be assessed by surveying alumni. One year after graduation, at least 90% of respondents to the GT undergraduate alumni survey will indicate they received "excellent" or "good" preparation in methodological and quantitative problem-solving skills, as well as in experimental techniques.

Evaluation procedure 2d: One year after graduation, at least 90% of supervisors or graduate advisors of alumni who respond to the GT employer survey will indicate that program graduates have "excellent" or "good" understanding and skills relative to scientific methodology, quantitative problem-solving, and experimental techniques.

### **3. Computer and Information Literacy:**

Students will demonstrate effective use of computers and libraries, in concert with their overall studies.

Evaluation procedure 3a: Upper division courses within the major (Phys 3121-2, Phys 3141, Phys 3211 and Phys 3143) involve students in using computers for numerical problem solving, for simulations, and within experimental environments. Student ability will be assessed in these courses via on-line problem assignments, simulations, and experiments. Student performance in these areas will be sampled, and comparisons of median performance will be made over time. 90% of students sampled will demonstrate the acquisition of adequate skills.

Evaluation procedure 3b: Advanced courses within the major (Phys 3121-2, Phys 3141, Phys 3211 and Phys 3143) include information retrieval as an integral component. Student ability to retrieve information from library sources, from non-library databases, from the Internet will be assessed in these courses via written assignments and assignments printed from online sources. Student performance in these areas will be sampled, and comparisons of median performance will be made over time. At least 90% of students will be able to demonstrate acceptable competency in information retrieval from all sources.

Evaluation procedure 3c: In exit interviews, at least 90% of graduating seniors interviewed will indicate that they received "excellent" or "good" preparation in computing and information retrieval skills.

### **4. Scientific Reasoning:**

Students will demonstrate proficiency in analyzing and critiquing the development of physics ideas in presentations, published texts, reports, and research proceedings.

Evaluation procedure 4a: In the senior seminar sequence (Phys 4601-02), students will critique oral presentations of guest lecturers. A sample of these critiques will be selected and analyzed by at least two faculty members. At least 90% of student critiques will demonstrate acceptable proficiency.

Evaluation procedure 4b: In the senior seminar sequence (Phys 4601-02), students will write critical reports that relate to active physics research areas from published texts, reports, and conference proceedings. A sample of these critical reports will be selected and analyzed by at least two faculty members. At least 90% of student critiques will demonstrate acceptable proficiency.

### **5. Knowledge of Core Physics and its Applications:**

Students majoring in physics will understand principles of the primary areas of physics and will develop a facility for advanced study in chosen specialized areas.

Evaluation procedure 5a: In the senior capstone project reports and presentations, students will demonstrate knowledge of the basic areas of physics (classical mechanics, electromagnetism, quantum mechanics, and statistical physics). The project reports will be read by two faculty members and evaluated for understanding of the basic areas of physics. Project presentations will be evaluated by two faculty members, and external evaluators where possible. A scoring rubric will be used, and scores will be compared between raters. At least 90% of students will meet minimum standards for performance in this area.

Evaluation procedure 5b: In the senior capstone project reports and presentations, students will demonstrate knowledge of advanced, specialized areas of physics such as optical, atomic, nuclear, solid state, and non-linear physics, according to their area of specialization. The project reports will be read by two faculty members and evaluated for understanding of the basic areas of physics. Project presentations will be evaluated by at least two faculty members, and external evaluators where possible. A scoring rubric will be used, and scores will be compared between raters. At least 90% of students will meet minimum standards for performance in this area.

Evaluation procedure 5c: As a required portion of the senior sequence, all graduating seniors will take the Physics subject test of the GRE and will be asked to report their results to Georgia Tech. This will provide the program with objective evidence of student knowledge relative to student knowledge of core physics and its applications. 90% of graduating seniors will score at or above the 90<sup>th</sup> percentile on the Physics subject test.

## **6. Preparation for Careers and/or Graduate Study:**

Students will be prepared for a career in a scientifically or technically oriented business or industry, or for graduate study in physics or other scientific or technical fields.

Evaluation procedure 6a: In exit interviews, 90% of graduating students who are interviewed will indicate that they have been "very well" or "well" prepared for a career in a technically oriented business or industry, or for graduate studies in physics or other scientific or technical fields.

Evaluation procedure 6b: Respondents to the GT undergraduate alumni survey in physics will be asked to specify their satisfaction with career preparation and/or graduate study. At least 90% will respond that they received "excellent" or "very good" preparation in this regard. In addition, 90% of respondents to the alumni survey will indicate that they were placed into a full-time professional position within their discipline or into a graduate program in physics or other scientific or technical fields within 6 months of graduation from Georgia Tech.

Evaluation procedure 6c: On the GT Employer Survey, 90% of responding supervisors or major professors of physics alumni from GT will indicate that students received "excellent" or "very good" preparation for a career position or for further graduate study.

Evaluation procedure 6d: As a required portion of the senior sequence, all graduating seniors will take the Physics subject test of the GRE and will be asked to report their results to Georgia Tech. This will provide the program with objective evidence of student preparation for graduate study. 90% of graduating seniors will score at or above the 85<sup>th</sup> percentile on the Physics subject test.

## **IMPLEMENTATION PLAN**

The undergraduate coordinator will have overall responsibility for maintaining data collection, reporting, and dissemination of assessment results to faculty in the School of Physics. Our Undergraduate Committee will be responsible for considering and enacting curricular changes in the light of assessment findings within the School of Physics. Specific measurement implementation includes:

Online Assignments: Student ability will be assessed in these courses via on-line problem assignments, simulations, and experiments. Student performance in these areas will be sampled, and comparisons of median performance will be made over time. On an annual basis, data will be provided by the faculty member of record for Phys 3121-2, Phys 3141, Phys 3211 and Phys 3143 to the undergraduate coordinator, who will be responsible for analyzing group-level student performance.

Written Class Assignments: Student ability to retrieve information from library sources, from non-library databases, from the Internet will be assessed in Phys 3121-2, Phys 3141, Phys 3211 and Phys 3143 via written assignments and assignments printed from online sources. Student performance in these areas will be sampled, and comparisons of median performance will be made over time. On an annual basis, data will be provided by the faculty member of record for these courses to the undergraduate coordinator, who will be responsible for analyzing group-level student performance.

Capstone Course Assessments: The faculty member of record and one other faculty member will each rate student written and oral presentations. They will compare their ratings to those of invited external raters, will summarize the findings, and will forward the results to the undergraduate coordinator each semester. The undergraduate coordinator will present the summarized results on an annual basis to the Physics faculty.

GRE Subject Tests: These tests will be administered as part of the senior capstone course. The results will be reported back to GT, and it will be the responsibility of the undergraduate coordinator to retrieve and assemble the results for presentation on an annual basis to the Physics faculty.

Exit Interviews: Exit interviews will be conducted by the school chair and by the undergraduate coordinator. Results will be summarized and disseminated to faculty by the undergraduate coordinator on an annual basis.

Alumni and Employer Surveys: Surveys will be administered by the GT Office of Assessment on an annual basis. Results will be disaggregated and provided to the School of Physics in a format where the responses of Physics alumni and responses of the supervisors of Physics alumni can be compared to all College of Sciences results and to GT results for that year as a whole.

**School of Physics**  
**Bachelor of Science in Physics & Bachelor of Science in Applied Physics**  
**Intended Learning Objectives/Outcomes and Assessment Methods**

*Intended Learning Objectives/Outcomes*

Communicate in both written and oral forms	Understanding and application of methodology, problem-solving, and experiments.	Effective use of computers and libraries	Proficiency in analyzing and critiquing the development of physics ideas	Knowledge of Core Physics and its applications	Preparation for Careers and/or Graduate Study
1	2	3	4	5	6

*Assessment Methods*

Online class assignments	1			✗			
Written class assignments	2			✗			
Capstone Course Written Reports	3	✗			✗	✗	
Capstone Course Report Presentation	4	✗	✗			✗	
GRE Physics Subject Test	5		✗			✗	✗
Exit Interviews	6			✗			✗
Alumni Survey	7	✗	✗				✗
Employer Survey	8	✗	✗				✗

**EVALUATION RESULTS**

Evaluation results will be featured yearly in annual assessment updates entered into OATS and every three years in strategic plans.

**FEEDBACK CHANNELS**

Assessment results will be disseminated to program faculty and discussed at the annual Physics retreat, to fully discuss assessment findings, to determine to what extent the curriculum is functioning as intended, and to come to agreement on any needed changes. Assessment results will be available on the web to program faculty two weeks prior to the annual retreat to allow time for individual reflection and analysis prior to the retreat.

**USE OF RESULTS**

Use of results for program modification and the subsequent impact of any changes made will be discussed each year in annual assessment updates in OATS and will be summarized every three years in strategic plans.