STUDENT LEARNING OUTCOMES and ASSESSMENT

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INTRODUCTION

In a traditional physics curriculum like the one at GSU, the core subject areas are:

1. Mechanics (classical and relativistic);
2. Electricity and magnetism (including optics);
3. Heat and statistical physics;
4. Quantum physics.

Instruction in these subject areas is approached in a "layered" fashion with typically three layers (or levels): freshman-sophomore, junior-senior, and graduate. The different levels are distinguished in two ways: by application of more sophisticated mathematical techniques and by requirement of more comprehensive analytical skills. The quantitative nature of physics and astronomy means that a solid preparation in mathematics is an important prerequisite to these areas. Our curricula require math courses up to the level of partial differential equations and vector analysis.

GENERAL LEARNING OUTCOMES (G)

Desired outcomes for students exiting programs in Physics and Astronomy have content-based, skill-based, and analysis-based elements. A general summary of these elements is as follows:

G1. Knowledge of principles and concepts for specific core subject areas;

G2. Ability to apply principles and concepts to analyze problems within specific core areas;

G3. Capability with quantitative methods appropriate for the core areas;

G4. Ability to analyze and interpret quantitative results (critical thinking);

G5. Experience with integration of concepts: analysis of complex problems cutting across multiple core areas;

G6. Ability to collect and appropriately analyze data working independently and in collaboration with others (experimentation, data collection, model-based computation, and literature research using basic and state-of-the-art technology);

G7. Ability to communicate orally and in writing by making appropriate use of current presentation technology;

G8. Familiarity with current developments in physics and astronomy.

CONTENT-BASED GOALS (C)

To achieve these outcomes, the undergraduate and graduate curricula require coursework with nationally-standard coverage of the core subject areas. As specific content objectives for the core areas, students who complete the department-based courses should:

C1. have a working knowledge of classical mechanics and its application to "standard" problems such as central forces and rotational dynamics;

C2. understand the principles of special relativity and have a working knowledge of its application to the mechanics of particles;

C3. have a working knowledge of basic electrostatics, electrodynamics, and magnetism leading to the development of Maxwell's equations;

C4. have a working knowledge of geometrical and physical optics;

C5. have a working knowledge of basic thermodynamic principles and the relation of statistical mechanics to them;

C6. have a working knowledge of elementary quantum mechanics and its application to the explanation of atomic structure and atomic spectroscopy;

C7. have basic skills in laboratory practice including a working knowledge of data analysis.

OVERVIEW OF THE APPROACH TO ASSESSMENT

Undergraduate Program: The undergraduate curriculum is centered on a 30-hour set of upper-level mathematics and physics courses comprising the “core” of the major. From the foundation provided by the core, students may choose the standard physics option, intended to prepare students for graduate school in physics, or they may choose from a group of several concentration areas (astronomy / astrophysics, applied physics / engineering, biophysics, pre-medicine, computer science, and geology). Each concentration was established in areas naturally related to physics so that the substantial foundation provided by the core makes these fit into the broad category of “applied physics.”

At the undergraduate level, assessment data comes mainly from embedded sources. Specifically, the content-, skill-, and analysis-based elements generally are integrated within (and inseparable from) each assignment and examination during the term. Consequently, evaluating student performance on the assignments and examinations provides a continuous update on the success with which the specific courses are meeting the learning objectives for each student cohort. It is important to note that the course-specific data also provides information on success in meeting the “integration of concepts” outcome. This occurs because the higher-level courses inevitably incorporate elements from other specific core areas (*e.g.,* applications of electricity and magnetism easily require analysis with principles from mechanics; descriptions of astrophysical systems incorporate principles of electricity and magnetism and those of statistical physics).

The content-based assessment items above primarily describe the core. However, the undergraduate program also requires a senior research project (PHYS 4950), the topic of which reflects the specifically-chosen concentration. This project will provide the data for a more direct assessment of the success with which the “integration” goal is met for the overall program; also, it will indicate the success in meeting the general goal of applying physics to problems from these concentration areas. At the undergraduate level, there is more emphasis on written than oral communication. All laboratory courses require written reports, and the evaluations of these provide the data for assessing the success with which this goal is met.

The matrix below illustrates the primary relationship of each course in the physics / math core to the general and content-based goals.

Undergraduate Program

Course	***PHYS 3401***	***PHYS 3402***	***PHYS 3800***	***PHYS 3850***	***PHYS 3901***	***PHYS 3902***
General	G1-G5	G1-G5	G1-G4	G1-G4	G1-G8	G1-G8
Content	C2, C4, C6	C1, C3, C6	C4	C5	C4, C6, C7	C6, C7
Course	***PHYS 4600***	***PHYS4700***	***PHYS 4950***	***MATH 3260***	***MATH 4258***	***MATH 4265***
General	G1-G5	G1-G4	G1-G8	G1-G4	G1-G4	G1-G4
Content	C1	C3	C6, C7			

Graduate Programs: Although based on sets of required courses (both subject- and topic-based), the graduate programs much more strongly emphasize the "integration" and "communication" goals. The topic-specific graduate courses routinely require students to prepare a written report on a subject relevant to the course, and to present the report orally. In addition, all M.S. students (thesis or non-thesis) must write a report and make an oral presentation on their research project. Students at the Ph.D. level, of course, must demonstrate a high degree of capability to integrate the principles from coursework to meet the requirements of the Qualifying Examinations, to successfully meet the original-research requirements of the Ph.D. degree, to prepare the Ph.D. dissertation, and to defend their work.

The table below indicates the primary relationship of basic graduate courses to the general and content-based goals.

Graduate Programs

Course	***PHYS 8010***	***PHYS 8100***	***PHYS8110***	***PHYS 8210***	***PHYS 8310***	***PHYS 8710***	***PHYS 8910***
General	G1-G5	G1-G5	G1-G5	G1-G5	G1-G5	G1-G8	G1-G8
Content	C1, C2	C3, C4	C3, C4	C6	C5	C1-C8	C1-C8
Course	***PHYS 8999***	***PHYS 9999***	***ASTR 6000***	***ASTR 8710***	***ASTR 8900***	***ASTR 8910***	***ASTR 9999***
General	G1-G8	G1-G8	G1-G8	G1-G8	G1-G8	G1-G8	G1-G8
Content	C1-C7	C1-C7	C1-C3, C5, C6	C1-C7	C1-C7	C1-C7	C1-C7

IMPLEMENTATION PLAN FOR ASSESSMENT

Specific Data Sources and Assessment Methods, B.S. Program: The general success of the undergraduate curriculum in guiding students who enter the program to success in meeting the learning outcomes will be assessed at course-specific and overall levels as follows:

Ugrad-1. Working in collaboration, the Committee on Undergraduate Instruction and the instructor of each core course will identify appropriate items from the students' work reflecting both the general and the content-based goals. (Items providing the data can include student response to test questions as well as samples of students' writing from lecture and lab courses.)

Ugrad-2. Also, at the end of each semester, instructors in these courses will be asked to provide from their perspective an overview of the course including information such as: things which worked well for this group of students; things they wish they had done differently; new ideas for material, examples, *etc.*, to incorporate at the next offering of the course; any unusual characteristics of the particular set of students.

Ugrad-3. Overview information for the complete program, including the students' selected concentrations, will come from copies of PHYS 4950 reports and an assessment of the overall work by the faculty directing the project.

Ugrad-4. A second piece of overview information will come from an exit interview soliciting from students an overall assessment of their experience in the department: things which went well; things they wish they had done differently (for future advising purposes), things they wish the department had done differently; things (courses, advising, student academic support, *etc.*) they wish the department had offered.

Specific Data Sources and Assessment Methods, M.S. and Ph.D. Programs: Admission requirements generally select students entering the graduate programs for those with demonstrated capabilities in the content areas. Therefore, the primary assessment parameter for these students is the success with which they advance to the capability of initiating, carrying out, and reporting on original research. A secondary parameter, however, is the development of their instructional abilities. Existing evaluations of each graduate student which provide programmatic assessment data are:

Grad-1. Establishment of, and interaction with, advisory committees;

Grad-2. Non-thesis M.S. project report and oral presentation;

Grad-3. M.S. thesis and defense;

Grad-4. Ph.D. qualifying examinations;

Grad-5. Required enrollment in Phys/Astr 6300 courses for development of laboratory teaching skills;

Grad-6. Required enrollment in Phys / Astr 6310 courses for maintenance of laboratory teaching skills;

Grad-7. Preparation, presentation, and defense of Ph.D. dissertations.

ASSESSMENT-BASED IMPROVEMENTS AND ADJUSTMENTS

Normally, each instructor reviews the outcome-based progress of students in individual courses as they are underway, and makes any obvious adjustments in real-time. The department's committees (the Committee on Undergraduate Instruction, and the Graduate Program Committees in Physics and in Astronomy) systematically review assessment data to identify any modifications of content and instruction which can improve the degree to which the students exhibit success in meeting the intended outcomes. These reviews may also provide the basis for course and / or curricular modifications.

REVIEW OF ASSESSMENT METHODS

Since this document describes the Department's initial plan for formally assessing student learning outcomes in its degree programs, it is appropriate that the methods described above should also be assessed periodically for effectiveness and modified as appropriate by the faculty.