Program Assessment Plan
Department of Physics
(Fall, 2011)

Learning goals:

1) Students can design procedures for controlled experiments, interpret data graphically and statistically, and perform error analysis, including error propagation and identification of systematic and random errors. Students can skillfully operate standard laboratory equipment such as oscilloscopes, function generators, multimeters, power supplies, frequency counters, spectrometers, and measuring instruments with vernier scales. They understand the limitations of the instruments and equipment.

2) Students can gather information from a variety of sources and combine in a thoughtful way, along with background knowledge, into a coherent presentation. Students have proper degree of skepticism and awareness of the possibility of errors in sources and are sensitive to contradictions and ambiguities. Students ask questions that a trained physicist would naturally ask in a given situation and seek clarification until a satisfying conclusion is reached.

3) Students achieve a working knowledge of the major fields of physics – Newtonian mechanics, classical electricity and magnetism, waves, thermodynamics, special relativity, and quantum mechanics. They understand the consequences of the basic conservation laws of energy, momentum, angular momentum, and electric charge. They are capable of solving problems that require combining concepts from multiple fields.

4) Students achieve a level of mathematical competency that enables them to solve a wide variety of problems in physics. These include multivariate and vector calculus, ordinary and partial differential equations, vectors and tensors, matrix algebra, and functions of a complex variable.

Assessments:

1) Laboratory reports are collected periodically for selected labs in the three introductory courses. Every few years these are examined by a committee of the physics department to look at the progression of knowledge and skills in the three courses. By the time students are in the third course (Modern Physics), we expect a certain degree of competence and even sophistication in experimental design, graphical and statistical data analysis, and error analysis. For instance, choosing different functions of the variables to be plotted can not only linearize the data in many circumstances, but can also be designed

to eliminate a possible systematic error. If a skill appears to be missing here, we look at where this is introduced and used in the previous courses to determine if it is a lesson not learned or not taught, or a lesson learned but not retained. This allows us to redesign or change emphasis in the earlier courses to meet the learning goals assessed in the later course.

2) The undergraduate seminar course (PHYS 400), taken toward the end of a student's tenure at Fredonia, provides an opportunity for students to research a modern topic in physics and present a talk. The talks are evaluated by both students and faculty. At the end of the semester, the faculty examine summaries of the evaluation forms and discuss whether the talks met our expectations given in learning goal (2) above. When deficiencies are noted, especially if they occur multiple times, we attempt to identify where in the curriculum they can be remedied.

3) We have implemented an exit exam which is given in the PHYS 400 course. The grade on the exam counts in a minor way toward the grade for that one-credit course, in order for the students to take the assessment seriously. The exam in its current form consists partly of a nationally-normed test in mechanics (Mechanics Baseline Test), along with questions from the other fields mentioned in learning goal (3) which have been developed by faculty or taken from a variety of public-domain sources. These questions are similar to those occurring on the physics GRE exam. Examination of results is expected to help identify specific areas of the curriculum that need improvement or emphasis. It is also hoped that this exam can assess whether students are capable of combining ideas from different areas effectively. Also, since they are asked to explain their reasoning on the test we hope to learn about student thought processes and misconceptions.

4) All students in physics programs take PHYS 425, Mathematical Physics I, and all students outside the education program also take PHYS 426, Mathematical Physics II. Performance in these wide-ranging courses covering many different areas of mathematics with applications to physics serves to assess the effectiveness of earlier courses in calculus and differential equations, as well as students abilities to use math to solve physics problems. The department feels that mathematical ability is adequately assessed within these capstone courses, and copies of exams in these courses are kept which are periodically evaluated by faculty.

5) The "Force Concept Inventory (FCI)" a nationally normed mechanics concept test is given to students in University Physics I both at the beginning and end of the course. Results are examined each year and discussed by the department as a whole in helping to shape the curriculum and instruction methods of this important first course in the physics major. Although different from the mechanics part of the exit exam, there exists data on how the norms of these tests are related, so a comparison to the exit exam can also be made to examine retention of ideas and conceptual gains over the remaining curriculum.

Timeline:

Every spring the assessment test (3) and two administrations of the FCI test (5) are graded and the department as a whole meets and examines the results. This wide-ranging discussion is then used to devise specific proposals for course modifications and improvements or changes in the program. The other learning goals (1), (2), (4) are each assessed every four years on a rotating basis using a similar procedure (the fourth year is left open for a more experimental assessment activity which will hopefully help the system evolve). In each case the relevant student work is collected and summarized, examined by the faculty as a whole, discussed, and concrete proposals for improvements are distilled.

Responsibilities:

The department chair is responsible for initiating the meetings, writing reports, and leading the discussion. Individual faculty are assigned to collect the data, help design and grade the assessment instruments such as the exit exam, participate in the discussions and formulation of improvement plans, and, most importantly, implementing these plans in their courses.

Record keeping:

Minutes of assessment meetings are kept in the department office, and a summary of assessment activities is contained in the department annual report.

Processes for using assessment results to improve learning

Whenever possible, the assessment discussions mentioned earlier are followed by the setting of specific goals, plans for improvement, action items etc. These are tried the next year and their effectiveness is again assessed the following year. Of course it must be recognized that not all changes will be good ones and that change is not a goal in itself.