Physics Assessment Report

Guidelines for Departmental Assessment Reports—2014-2015

Please complete your departmental assessment and provide a narrative for the following areas of analysis.

1. Provide your action items from your 2013-2014 report and describe your progress in addressing those action items. Were you able to accomplish your action items? If you were not please provide a discussion of impediments.

2. Describe the departmental learning outcomes and assessment activity that your department completed for 2014-2015.

3. Provide a summary of your assessment results.

4. Indicate how your department used the assessment results (describe your reflections).

5. Clearly describe your action items that you would like to implement for the next academic year. Remember, your focus should be aimed at actions that will improve student learning.

    a. Indicate any reallocation of resources that may result from your proposed action plans (resources include budget and student/faculty time).

1. Action items from 2013-2014:

The students need more guidance on what is expected of them.

a) Students should be given examples of the proper structure of a scientific paper. This should perhaps also be reinforced at earlier portions of their college career in lab reports.
b) Students should understand the importance of primary sources, and how to perform a literature review.
c) Students should be involved in an active discussion of published research that is to be used as a template.
d) Students should be kept on schedule with specific deadlines for topic, data collection, drafts, and the final paper.
e) A part of the process should be a presentation of their research.

We were able to accomplish most of the action items including more extensive guidance, a stricter schedule for intermediate steps in their projects and their completion, a better understanding of structure, extent, and organization of a scientific paper worth of publication or presentation by the students.

All senior projects have been presented orally by the students, one was made a poster presentation in addition to an oral presentation, the other was also presented on a national conference by the student.

What has not (yet) been done to the desired extent is a discussion of published research, literature

review and the structure of scientific papers ***earlier*** in the curriculum in upper-level courses.

2. Departmental learning Outcomes and Assessment activity 2014-2015 and

3. Assessment results

both attached as File "Physics Department Learning Outcomes" in appendix

4. Use of assessment results and reflection

The physics department felt the need for an improvement of the senior theses, which are meant to be a demonstration of the mastery of fundamental concepts, lab and technical skills, writing scientific papers, and applying advanced math to theoretical and experimental problems in physics.

Last year's physics theses show a marked improvement in quality over previous years. They are longer, show more detail, have better references and reviews of the relevant literature, and have been given an oral summary on conferences (both at Thiel and elsewhere)

Some work still needs to be done in upper-level courses concerning the appreciation of scientific research and literature.

5. Action items for 2015-2016

* Both faculty members of the physics department have participated in the Hodge series seminars concerning assessment and development of SEMS 100 and INDS 100 and considered which physics courses would be suitable for becoming a PIC course

* Dr. Hecking is in the process of adding a PIC component to Phys 353 (Intermediate Lab)

* Phys 253 (Statics & Dynamics) and Phys 363 (Mathematical Physics) always had a presentation component. In the past this was limited to one-time brief demonstration of an interactive spreadsheet program summarizing the results from a semester project, during the time slot reserved for the final (the final was a take-home exam). We are discussing the possibility of turning both into PIC courses as well.

* Dr. Torigoe is beginning research on student education with a senior (Dominic Licata) with the goal of preparing a senior thesis on this subject.

* Dr. Torigoe is continually working on improvements of the electronics course – Analog Electronics (Phys 213) has been upgraded to a 4 CH course, both to improve the depth of learning as well as satisfy requirements of the 3-2 binary engineering program, at least what Pitt is concerned. In the future, possibly there will be a new course (Phys 293) combining both analog and digital electronics.

Reallocation of resources

All of the above is conducted within the usual faculty load for Drs. Hecking and Torigoe; no particular big-ticket budget items such as expensive apparatus are expected to be needed.

Appendix

Physics Department Learning Outcomes

Three programs:

Physics **Dual Degree Engineering (3-2)** **Physics Sec. Education**

Only physics is entirely under control of the physics department, the dual degree program is administered at an engineering school for the last two year of the (3-2) program; physics secondary education is taught jointly with the education department, which conducts education courses, mentoring, and student teaching.

A thesis/seminar is required only for physics and physics education students.

Knowledge:

A) Fundamental concepts of the physical world, as they extend to mechanics, thermodynamics, optics, electromagnetism, relativity, atoms, the solid state, and elementary particles

B) The scientific method, and the concepts of precision and accuracy of measurements and data

AS) Have a basic understanding of the solar system, the nature of stars, and the universe at large, be able to identify celestial objects through a telescope and read and use star charts (only K-12 teachers)

Skills:

C) Laboratory skills and techniques covering the handling of instruments and apparatus; making mechanical, electric, optical and thermal measurements

D) Mechanical skills: wood and metal working, construction and assembly of experiments and apparatus

E) Mathematical, computational, and spreadsheet skills applied to typical physics/engineering applications

Judgment:

F) Proper interpretation of data, charts, diagrams, scientific and technical publications

Preparation:

J) Readiness for K-12 teaching

Courses:

Physics:	*Physics teaching*	*Dual degree (3-2) Engineering*
Phys 174 (Intro I)	Phys 123 (Astronomy)	Phys 174
Phys 184 (Intro II)	Phys 174	Phys 184
Phys 213 (Analog Electronics)	Phys 184	Phys 263
Phys 223 (Thermophysics)	Phys 263	Phys 353
Phys 243 (Digital Electronics)	Phys 353	Phys 363
Phys 253 (Statics & Dynamics)	Phys 223 or 253 or 343	0-3 more depending on engineering specialty
Phys 263 (Modern Physics)	Phys 213 or 243	
Phys 343 (Electromagnetism)	Phys 424	
Phys 353 (Intermediate Lab)		
Phys 363 (Mathematical Physics)		
Phys 424 (Seminar/Senior project)		
Calculus I	Calculus I	Calculus I
Calculus II	Calculus II	Calculus II
Calculus III	Calculus III	Calculus III
Differential Equations	CIS 111+112 (Spreadsheet and word processing)	Differential Equations
Chem I	Chem I or Chemtech	Chem I
Chem II		Chem II
Intro Computer Science	Bio, health, English and education courses as required by the Education Department	Intro Computer Science
		More electives from Computer science, Math, or Chemistry depending on engineering specialty

Concerning the assessment of learning, the following abbreviations are used:

E	exams
Q	quizzes
H	homework assignments
T	term papers
P	projects
L	lab reports

Physics

Outcome	Course introduced	Course Reinforced	How assessed
A	174, 184	223, 253, 263, 343	E, H, P
B	174-lab, 184-lab	353	E, Q, L
C	174-lab, 184-lab, 213, 243	353	E, Q, L, P
D	424	424	T
E	Math – calculus sequence	363 and other upper-level courses	E, H, P
F	174, 184	213, 223, 243, 253, 263, 343	E, H, P, L

Physics education (exact curriculum is elective)

Outcome	Course introduced	Course Reinforced	How assessed
A	174, 184	263, 223 or 253 or 343	E, H, P
B	174-lab, 184-lab	353	E, Q, L
C	174-lab, 184-lab, 213 or 243	353	E, Q, L, P
D	424	424	T
E	Math – calculus sequence	other upper-level courses	E, H, P
F	174, 184	213 or 243, 263, 223 or 253 or 343	E, H, P, L
AS	123	None; stand-alone 1-term course	E, Q, T
J	Education courses, not conducted by the Physics Department		

Binary Engineering (exact curriculum depends on engineering specialty)

Outcome	Course introduced	Course Reinforced	How assessed
A	174, 184	263, (223, 253, 343)	E, H, P
B	174-lab, 184-lab	353	E, Q, L
C	174-lab, 184-lab, (213, 243)	353	E, Q, L, P
E	Math – calculus sequence	363 and other upper-level courses	E, H, P
F	174, 184	263, (213, 223, 243, 253, 343)	E, H, P, L

The distinction between "course reinforced" and "course assessed" is not entirely meaningful, assessment occurs at all levels.

All representative syllabi are available on demand.

The final paper/project/seminar is NOT intended to encompass all learning outcomes, rather to emphasize specific skills, knowledge, or judgment from the groups A – F. Obviously, some level of expertise in all of them is necessary to produce a successful thesis/project, but the relative weight of these may vary substantially from one thesis/project to another, or even within one project, if more than one student is involved.

Two senior (physics major) theses were chosen for assessment (no phys ed major graduated this year):

A) An experimental/theoretical work concerning Fourier analysis of electric circuits at Thiel
B) An internship at a national laboratory concerning data analysis and sensor – data storage interfacing; accepted as senior thesis because of similar scope and difficulty

Scoring Rubric for senior paper/project/seminar - Phys major A– reader 1	
Outcome	The paper gives a brief theoretical overview over the concept of Fourier analysis, then calculates specific results for some special cases of wave forms. Output measurements of a circuit entirely constructed by the student confirmed the theory. An "Arduino" chip was attached to the circuit to give a visual display of the Fourier spectrum
A	In order to execute the project, knowledge of electromagnetism as one of the fundamental concepts of the physical world is obviously required
B	Extensive amounts of data (mostly amplitudes and frequencies) are taken, processed, and integrated with sufficient accuracy
C	The execution of the project requires the ability to construct a circuit, attach a variety of measuring Instruments to it, calibrate these properly and take measurements with sufficient precision
D	Mechanical skills were required; less of a "machine shop" nature, but rather assembling and properly Soldering small electrical components
E	Calculations had to be made to arrive at the end results; in this particular work advanced calculus was required. Spreadsheet calculations were employed to compile the final results.
F	The summary of results in this work requires interpretation of data, diagrams and tables, with sufficient reference to literature

Scoring Rubric for senior paper/project/seminar - Phys major A– reader 2	
Outcome	The paper describes the importance of the Fourier series, gives a mathematical description of how to find the amplitudes of each component, describes two circuits that she built and showed data that was collected for each circuit, which were compared to theoretical predications.
A	The student demonstrated an understanding of both digital and analog electronics. As shown in the construction of the circuits, and testing them with electronic equipment: function generator, oscilloscope, and multimeter. The student also demonstrated knowledge of the Fourier series, which was covered in math physics, and the electricity and magnetism classes.
B	The student took data related to voltage amplitudes, and signal frequencies. She compared the expected amplitudes to the theoretically predicted values. One area of improvement would have been to perform a formal error analysis. In the paper, she talks vaguely about the imprecision of the capacitors, inductors, and resistors.
C	She used many electrical apparatus to take data: function generator, oscilloscope, and multimeter.
D	She constructed the circuits. The second circuit required her to solder the components to a perf board.
E	She showed a derivation of the amplitudes of the Fourier series, as well as the specific equation for the square wave. The derivations were accurate, but she could have done a better job streamlining some of the argument, and putting some of it in more understandable conceptual terms. She also used Excel spreadsheets to tabulate, analyze, and graph her data.
F	The format is similar to what would be expected of a publication. It has an introduction, theory, description of apparatus, data, and conclusions. She also did a good job finding appropriate sources, and citing them.

Scoring Rubric for senior paper/project/seminar -- Phys major B - reader 1	
Outcome	In 2016 a state-of-the-art spacecraft will be launched which is expected to probe the low frequency spectrum of gravitational waves emitted by violent events in the universe. The sensor array of this craft requires calibration, a change of the program code from analog to digital computing, and an increase of its sensitivity. The student spent a 6-week internship at the prestigious Max-Planck -Institute (Germany)working on a variety of tasks related to this project.
A	In order to perform the research and write the paper, a wide variety of basic knowledge in optics, analog and digital electronics, and mechanics is necessary
B	The main challenge of this project is the acquisition of data with unprecedented precision through state-of-the-art technology. This requires a thorough understanding of the scientific method and appreciation for utmost accuracy concerning data
C	Electrical and optical measurements with high precision and advanced techniques must be performed
D	Construction and assembly skills are not required for this project, since the apparatus already existed. However, substantial skill in handling, connecting and adjusting the apparatus is needed.
E	A major part of this project is the rewriting and testing of code and its interaction with the physical apparatus. It requires a good command of the specific programming language and of linear algebra.
F	The summary of results in this work requires interpretation of data, diagrams and tables, with substantial reference to literature.

Scoring Rubric for senior paper/project/seminar -- Phys major B - reader 2	
Outcome	This paper is the result of an international internship at the Max Planck Institute in the summer of 2014. The paper describes her activities to test and calibrate an apparatus that is the precursor to a gravitational wave detector that will be sent to space.
A	She demonstrated knowledge in digital electronics, analog electronics, mechanics, and optics.
B	During the process of testing and calibration she did many activities that demonstrated that she regularly dealt with issues related to precision and accuracy. The bulk of her work dealt with feedback loops to minimize noise in the system.
C	The apparatus she was working with was extremely sensitive and delicate. Although she does not go into the details she must have taken and analyzed a lot of data to create the graphs she showed.
D	She did not build the apparatus, which was too complicated for a single individual. But she made adjustments to the apparatus to align the beams, so that the apparatus would function properly.
E	She demonstrated skills with matrix algebra, and although not specified, used software to analyze the data and to create the graphs that are throughout the paper.
F	There are a number of charts, and a relevant and properly organized bibliography. All of the citations were appropriate and properly formatted.

Areas of improvement in student project – Phys major A:

1) Some explanations of equations are a bit short, others unnecessarily lengthy
2) The discussion of the experimental apparatus could have been more detailed in the second part (Involving the function of the Arduino chip)
3) Overall writing style could be improved. There were some errors in grammar and spelling, not impeding the understanding of the material.

Areas of improvement for the student – Phys major B:

1) A better explanation of how the measurements and calibration she was making connected to the measurement of a gravitational wave. For example, how the test masses would be expected to move under the influence of a gravitational wave.

Areas of improvement for the Physics Department

Compared to some theses from earlier years, these two works constitute a substantial improvement. They are longer and much more detailed. Both students have given an oral presentation at Thiel's research symposium, and student B also at a national conference. We believe that the students receive now adequate guidance for their projects.

1) The proper structure of a scientific paper should be reinforced at ***earlier*** times in their college career in lab reports.
2) Students should better understand the importance of primary sources, and how to perform a literature review.
3) Students should be involved in an active discussion of published research that is to be used as a template, perhaps during the intermediate lab (Phys 353) or other upper-level courses.