Institutional Effectiveness Report
Academic Year 2014-2015
Physics, Industrial Engineering, and Engineering Technology

Joe H. Mehaffey
Coordinator of Program Effectiveness

David M. Peterson, PhD.
Chair

Mission and Goals

Physics

The Department of Physics and Astronomy offers a baccalaureate degree in Physics with a concentration in Computational Physics or Health Physics. Students completing the majors offered by the department will be prepared for careers in industry and scientific research or for graduate school.

Industrial Engineering

Industrial engineers analyze and evaluate methods of production and help organizations improve systems and processes that improve quality and productivity. They work to eliminate any waste of time, money, materials, energy, and other commodities. An industrial engineering graduate will be prepared for a career in business, health care, consulting, government, or manufacturing. The industrial engineering program provides students with a rigorous study of the theory of the Industrial Engineering discipline, including areas of physics, mathematics, and business.

Engineering Technology

The Francis Marion University B.S. degree programs in Civil Engineering Technology (CET) and Electronics Engineering Technology (EET) allow students with an associate's degree in Engineering Technology or those in pursuit of such a degree to earn their bachelor's degree after approximately two years of additional coursework. FMU's Engineering Technology programs provide a unique cooperative educational opportunity to students and workers of the Pee Dee region and South Carolina by offering a liberal arts education to Engineering Technology students from the state's Technical Colleges in addition to their chosen technical and scientific training. The Engineering Technology degree programs enable graduates to compete more effectively for technical positions within local and regional industry.

Given the change in focus of the Institutional Effectiveness Report, particularly in the areas of Student Learning and Development and the measurements of such, we have chosen to continue with the previous reporting efforts for this year while including a framework for improved measurements of student learning outcomes in subsequent years. Due to the timeframes involved, we have limited data using the new model for this year. In next years' report, 2015-16, we expect to have completely moved to the new framework and will have a complete set of data as outlined toward the end of this document.

Assessment Activities

Student learning and development	**2009-2010**	**2010-2011**	**2011-2012**	**2012-2013**	**2013-2014**	**2014-2015**
All laboratory courses will require mandatory written lab reports. Benchmark: 70% of the physics and engineering technology majors who complete the 300 and 400 level physics laboratory courses will submit a complete set of laboratory reports for each course.	22/28 (79%)	26/33 (78%)	29/39 (75%)	31/41 (76%)	29/41 (71%)	35/47 (74%)
Physics majors will complete one or more senior projects in PHYS 419 and 420 and will submit a written report. Benchmark: The written reports will be graded by two physics faculty members, assessed for accurate and clear scientific information reporting, and 70% of the students will score 4 or more on a 1-7 point scale.	7/7 (100%)	9/10 (90%)	8/8 (100%)	9/11 (82%)	7/9 (78%)	9/10 (90%)
Physics majors will be required to make at least one oral scientific report. An oral presentation based on a student's senior projects will be required as part of PHYS 397* and 420. Benchmark: Students will make an oral presentation at a special Society of Physics Students meeting, which will be evaluated by the physics faculty and at least one faculty member from another discipline for oral presentation quality. The mean score for these presentations should be at least 70 on a 100-point scale. * Physics 397-Research in Physics- has been added to this	0/0	3/3 (100%)	6/6 (100%)	15/16 (94%)	16/19 (84%)	15/16 (94%)

criteria beginning 2013. This explains the large increase in number of students.						
Instructional Technology	**2009-2010**	**2010-2011**	**2011-2012**	**2012-2013**	**2013-2014**	**2014-2015**
Students will be required to demonstrate the ability to use computers to solve physics problems Physics 301 or Physics 302 or Physics 401. Benchmark: one computer project will be completed in either physics 301, 302, or 401 and 70% of the students will score 4 or better on a 1-7 point scale of computer use, as assessed by two faculty members.	7/8 (87)	13/18 (72%)	15/20 (75%)	9/13 (69%)	8/11 (72%)	6/8 (75%)

Reviews Of Student Graduate School Admission And Fellowship Or Assistantship Acquisition	**2009-2010**	**2010-2011**	**2011-2012**	**2012-2013**	**2013-2014**	**2014-2015**
Within any four-year period, 80% of FMU physics graduates who apply to graduate school in a related discipline will be accepted.	3/3 (100%)	1/2 (50%)	2/2 (100%)	6/7 (86%)	2/2 (100%)	3/5 (60%)
One in eight of FMU physics graduates who are accepted to graduate school in a related field will receive a fellowship or assistantship.	3/3 (100%)	3/3 (100%)	1/1 (100%)	1/2 (50%)	2/2 (100%)	3/3 (100%)
Faculty Service To The University And To The Community	**2009-2010**	**2010-2011**	**2011-2012**	**2012-2013**	**2013-2014**	**2014-2015**
The level of involvement of the physics faculty in University committees will be evaluated through an examination of the faculty's annual reports. The benchmark for this activity is for the department's faculty, on average, to serve on at least two campus committees.	24/7 (3.4)	22/7 (3.1)	26/7 (3.7)	19/7 (2.7)	17/8 (2.1)	27/8 (3.4)
The extent of the physics faculty's participation in activities of the community at large is assessed through an examination of the faculty's annual reports. Value listed is the number of documented activities.	20	26	28	19	29	18

Issues and Actions

Issues of Concern	***Actions Taken***
Improvements to the Computational Physics major: Program requirements, course content, and facilities	• Dr. Engelhardt has been engaged in revising the PHYS 201-2 courses to include new learning strategies with online pre-lectures and several new laboratory experiments. • Dr. Engelhardt has also revised the PHYS 220 course (Computational Methods…) to use IPython notebooks along with the Python programming language. • Our dedication to student research projects seems to lead to the faculty teaching course overloads on a routine or continuous basis. A reasonable solution to this perceived problem has yet to be found.
Improvements to the Health Physics major: Program requirements, course content, and facilities	• Dr. Fulmer has revised the PHYS 418 (Practical Applications of Health Physics) course to require that students demonstrate proficiency in 'mining' relevant data from various scientific websites, and has sought to include more 'workplace' topics to better meet the needs of students who will enter the workforce directly upon graduation. • The Health Physics faculty continues to seek additional internship and scholarship opportunities for the HP students. At least four students are expected to perform internships during the summer of 2015.
Improvements to the Industrial Engineering major: Program requirements, course content, and facilities	• An additional part-time faculty member was hired to teach ENGR 220 (Materials Engineering); another full-time faculty member has been hired and will join the department in the fall. • An initial meeting of the Student Chapter of the Institute of Industrial Engineers was held, along with elections for officers. • Student Internship talks were held for the first time. In attendance were several of the sponsors from local industries. Relationship development with local industries and prospective employers continue to be a major focus of our efforts. • Drs. Peterson and Cintron-Gonzalez are in the process of forming an International Exchange agreement with the University of Applied Sciences, Jena Germany.

General improvements	• The upgrade to the University's planetarium nears completion. The new digital system represents a major improvement in the capabilities of the facility that serves both classes and public outreach efforts. In addition, several new telescopes have been added to the Observatory's arsenal. • Sophomore-level Industrial Engineering courses were offered for the first time. Also, an IE Speaker Series was instituted.
Recruiting of students	• The department's major recruiting effort, the South Carolina Engineering and Physics Scholars Institute (SCEPSI) has proven to be quite expensive, especially given the reduction in external support. While we will probably continue the program for this academic year, it may need to be scaled back or replaced with a more efficient recruiting program. • The department is planning to increase its outreach to the local high schools with faculty visits/ demonstration programs. We could also invite classes for an on-campus visit where appropriate. • The possibility to offer Engineering Technology courses in the Charleston/Mt. Pleasant area is being explored; could lead to an arrangement with Trident Technical College.

Assessment of General Education Courses

The Department of Physics and Astronomy has chosen to assess its General Education offerings by having students complete a survey concerning the results of an experiment they have just designed and completed. The techniques of data acquisition, experiment design, and analysis required in this experiment are considered representative of the students' mastery of the laboratory course material.

The experimental problem given to the students concerns a simple pendulum. The students must identify variables that may effect the time period of a pendulum (length, mass, amplitude) and investigate to see which one(s) actually have an influence. By analyzing the results, the students attempt to develop an empirical equation that correctly predicts the time period for any simple pendulum.

A copy of the survey questions and a reporting of the results follow.

SURVEY FOR PSCI 101 FINAL EXAM
SIMPLE PENDULUM EXPERIMENT

Directions: In response to the following questions, circle the answers that best characterize your results from the Simple Pendulum Experiment.

1. Did variations in the amplitude of the oscillating pendulum affect its time period?
   a) The amplitude had no effect on the time period.
   b) The amplitude seemed to have a slight effect on the time period.
   c) The amplitude had a major effect on the time period.

2. Did variations in the length of the oscillating pendulum affect its time period?
   a) The length had no effect on the time period.
   b) The length seemed to have a slight effect on the time period.
   c) The length had a major effect on the time period.

3. Did variations in the mass of the oscillating pendulum affect its time period?
   a) The mass had no effect on the time period.
   b) The mass seemed to have a slight effect on the time period.
   c) The mass had a major effect on the time period.

4. Which of the following expressions best characterizes the relationship between the time period (T) of a simple pendulum and its length (l)?
   a) $T = kl^2$
   b) $T = kl$
   c) $T = kl^2$
   d) $T = \frac{k}{l}$
   e) none of the above

Survey Results
(Last four years)

Question #/Response characterizations	**2011-2012 (211 students)**	**2012-2013 (230 students)**	**2013-2014 (258 students)**	**2014-2015 (244 students)**
1.Correct Incorrect/reasonable Incorrect	76 (36%) 119 (56%) 16 (8%)	88 (38%) 113 (49%) 29 (13%)	109 (42%) 131 (51%) 18 (7%)	55 (23%) 160 (66%) 27 (11%)
2.Correct Incorrect/reasonable Incorrect	182 (86%) 17 (8%) 12 (6%)	168 (73%) 54 (23%) 8 (3%)	224 (87%) 24 (9%) 10 (4%)	207 (85%) 25 (10%) 10 (4%)
3.Correct Incorrect/reasonable Incorrect	104 (49%) 97 (46%) 10 (5%)	109(47%) 104(45%) 17 (7%)	141(55%) 99 (38%) 18 (7%)	83 (33%) 137 (56%) 22 (11%)
4.Correct Incorrect/reasonable Incorrect	66 (31%) 93 (44%) 54 (25%)	123 (53%) 84 (37%) 23 (10%)	108 (42%) 108 (42%) 42 (16%)	50 (20%) 153 (63%) 40 (16%)

Commentary: This group's performance once again shows some mixed results with slight improvements in some areas, such as the ability to at least arrive at a 'reasonable' answer, but disturbing losses in the ability to obtain the *correct* answer in each case. In the fall semester, we had professors conducting the laboratory for the first time, possibly affecting the performance of ~40% of the students. However, the results from the spring semester showed no appreciable improvement, leading us to believe the cause of any poor performance lies elsewhere.

Beginning with the upcoming fall semester, we will begin conducting a similar experiment as a pre-test early in the semester. Hopefully, this will allow us to spot problems, get the students' attention, and lead them toward better approaches and experimental techniques. A more detailed description of this new approach will be outlined later in this report.

The remainder of this report serves to outline a proposal for an improved approach to the department's Institutional Effectiveness efforts. In particular, better measures of Student Learning Outcomes, both direct and indirect, will be pursued. This approach will be applied to all majors within the department and, where appropriate, to the General Education offerings as well. Some limited survey data from our graduating seniors has already been collected and will be presented.

Physics Major

Student Learning and Development

Student Learning Outcome (knowledge outcome, skills outcome, or attitude outcome)	Description of Assessment (direct or indirect)	Where/When the Assessment will be performed	Plans for subsequent improvement
Students will gain knowledge in introductory physics concepts. **(Knowledge outcome)**	Pre/post-test of students, measuring and reporting knowledge gains. **(direct)** Survey of students at end of course. **(indirect)**	Internally developed pre/post in each of PHYS 201 and 202. Multiple choice administered online (pre) and as part of final exam (post) Online survey administered near end of course.	Results will be analyzed and used as a basis for data-driven decisions on improved/new instructional/curricular approaches.
Students will gain knowledge in upper-level physics concepts. **(Knowledge outcome)**	Pre/post-test of students, measuring and reporting knowledge gains. **(direct)** Survey of students at end of course. **(indirect)**	Internally developed pre/post-test. Pre-test given at start of PHYS 316 (HP) and PHYS 306 (CP). Post-test given at end of PHYS 418 (HP) and PHYS 406 (CP). May use point system described by Lorna. Exit survey in Spring of senior year.	Results will be analyzed and used as a basis for data-driven decisions on improved/new instructional/curricular approaches.
Students will be able to use modern laboratory techniques to measure and analyze experimental data. **(Skills outcome)**	Instructor assessment of students' laboratory techniques and students' written analysis. **(direct)** Survey of students at end of program. **(indirect)** Survey of alumni 2-5 years	In PHYS 202, instructors asked to document this direct assessment based on performance in one, instructor-chosen laboratory experiment. Exit survey in Spring of senior year. Alumni survey post-graduation	Results will be analyzed and used as a basis for data-driven decisions on improved/new instructional/curricular approaches.

Student Learning Outcome (knowledge outcome, skills outcome, or attitude outcome)	**Description of Assessment (direct or indirect)**	**Where/When the Assessment will be performed**	**Plans for subsequent improvement**
	post-graduation. **(indirect)**		
Students will be able to competently present technical information via both oral and written communication. **(Skills outcome)**	Faculty will assess student presentations. **(direct)** Faculty assessment of student review article. **(direct)** Survey of students at end of course. **(indirect)**	PHYS 419 presentations PHYS 419 review articles Exit survey in spring of senior year	Results will be analyzed and used as a basis for data-driven decisions on improved/new instructional/curricular approaches.
Students will possess competency in physics-relevant computer skills. **(Skills outcome)**	Instructor assessment of an appropriate assignment in upper-level course. **(direct)** Survey of students at end of program. **(indirect)**	PHYS 417 or 418 (HP) PHYS 306 or 406 (CP) Exit survey in spring of senior year.	Results will be analyzed and used as a basis for data-driven decisions on improved/new instructional/curricular approaches.
Students will have an appreciation for physics including its significance and practical relevance. **(Attitude outcome)**	Survey of students at end of program. **(indirect)** Survey of alumni 2-5 years post-graduation. **(indirect)**	Exit survey in spring of senior year. Alumni survey post-graduation.	Results will be analyzed and used as a basis for data-driven decisions on improved/new instructional/curricular approaches.
Students will be prepared for a career or further study upon completion of program. **(Attitude outcome?)** (cont.) Students will be	Counting the number of graduates entering a career supported by the physics program. **(direct)** Counting the number of graduates entering graduate school. **(direct)** Counting the number of alumni working in a career supported by the program. **(direct)**	Exit survey in spring of senior year. Exit survey in spring of senior year. Alumni survey post-graduation.	Results will be analyzed and used as a basis for data-driven decisions on improved/new instructional/curricular approaches. Results will be analyzed and

Student Learning Outcome (knowledge outcome, skills outcome, or attitude outcome)	Description of Assessment (direct or indirect)	Where/When the Assessment will be performed	Plans for subsequent improvement
prepared for a career or further study upon completion of program. **(Attitude outcome?)**	Counting the number of alumni in graduate school. **(direct)** Asking graduates to assess their level of preparation for their career/graduate school. **(indirect)** Asking alumni to assess the role the program played in preparing them for their current career/studies. **(indirect)**	Alumni survey post-graduation. Exit survey in spring of senior year. Alumni survey post-graduation.	used as a basis for data-driven decisions on improved/new instructional/curricular approaches.

Industrial Engineering Major

The programmatic assessment described below has already been applied to the Industrial Engineering major. It has been designed to conform to the ABET (Accreditation Board for Engineering and Technology) requirements for engineering programs. It is expected that ABET accreditation for the program will be sought at the appropriate time, given that the Industrial Engineering program is relatively new and has of yet produced no graduates.

ABET Learning Outcomes	Performance Measures for Assessment	Where will Measures be obtained?	Plans for subsequent improvement
What students are expected to know at the point of graduation. Knowledge (k), skills (s) and attitude (a) outcomes are included in this list	*Measures will be collected by the instructor of each course. Direct measures (d) will be measured quantitatively by means of homework or exam problems, while indirect measures (i) will be measured qualitatively by means of evaluation of performance in presentations and/or projects.*	*Engineering courses where data will be collected for each learning outcome.*	*How data will be analyzed*
An ability to apply knowledge of mathematics, science, and engineering (s)	Apply equations of equilibrium to a 3D system in static equilibrium (d); Assess risk and safety for a work task and/or work station using NIOSH lifting guide, anthropometrics, etc. (i)	ENGR 301, 320, 373, 356	Results will be analyzed and used as a basis for data-driven decisions on improved/new instructional/curricular approaches. This process will involve input from the Physics and Astronomy Department as well as from a soon-to-be selected advisory board for the Industrial Engineering program.
An ability to design and conduct experiments, as well as to analyze and interpret data (s)	Design and conduct an experiment using fractional factorial design to optimize process variables (d); Analyze a production/service system using simulation to evaluate the effectiveness of different system designs or operational policies (i)	ENGR 373, 320, 356, 420, 468, 470	

An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability (s)	Generate and evaluate alternative facility layouts (d); Design work stations (layout, equipment, etc.) and/or work environments (lighting, temperature, etc.) while considering human capabilities and limitations and evaluate impact of design on productivity and worker health and safety (i);	ENGR 101, 420, 468, 470, 480	
ABET Learning Outcomes	**Performance Measures for Assessment**	**Where will Measures be obtained?**	**Plans for subsequent improvement**
An ability to function on multidisciplinary teams (a)	Understand effective teamwork capabilities/concepts (d); Work effectively on a team as evaluated by faculty and/or peers (i)	ENGR 480	Results will be analyzed and used as a basis for data-driven decisions on improved/new instructional/curricular approaches. This process will involve input from the Physics and Astronomy Department as well as from a soon-to-be selected advisory board for
An ability to identify, formulate, and solve engineering problems (k)	Formulate and solve a structured transportation/distribution problem using optimization (d);	ENGR 301, 330, 373, 470, 480	

An understanding of professional and ethical responsibility (k)	Understand ethical behavior in the workplace and ethical issues that affect decisions (d); Demonstrate professional behavior in interacting with sponsor in conducting senior design project (i)	ENGR 101, 480	the Industrial Engineering program.
An ability to communicate effectively (s)	Communicate effectively in written semester project report (i); Communicate effectively in oral presentation on semester project results (i);	ENGR 101, 420, 480	
The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context (k)	Perform benefit/cost analysis to evaluate economic impact of alternative design solutions (d); Assess and analyze effect of a change to process/methods on injuries and worker safety (i);	ENGR 420, 480	
ABET Learning Outcomes	**Performance Measures for Assessment**	**Where will Measures be obtained?**	**Plans for subsequent improvement**
A recognition of the need for, and an ability to engage in life-long learning (a)	Conduct a literature review for a semester project (d); Integrate literature research with project findings (i);	ENGR 420, 467, 468, 480	Results will be analyzed and used as a basis for data-driven decisions on improved/new instructional/curricular approaches. This process will involve input from the Physics and Astronomy Department as

A knowledge of contemporary issues (k)	Formulate and solve problem on emerging issues (e.g., homeland security or disaster response) (d); Understand improvement in technologies used globally (e.g., concurrent engineering, supply chain management, etc.) and how they impact organizations (i)	ENGR 330, 467, 468	well as from a soon-to-be selected advisory board for the Industrial Engineering program.
An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice (s)	Generate a process flow chart/diagram (d); Use a statistical software package to analyze data (d);	ENGR 101, 330, 320, 373, 480	

Engineering Technology

Given the unique nature of the B.S. in Engineering Technology degrees, these programs will require unique assessment activities. The 2-year Associate degrees awarded by Florence-Darlington Technical College are already ABET accredited. Francis Marion's contribution toward the Bachelor's degree contains few *required* courses above the 200-level. We propose, therefore, that the assessment activities relevant to the physics majors in the 201 and 202 lecture and laboratory courses also serve a similar function for the EET and CET programs.

Student Learning Outcome (knowledge outcome, skills outcome, or attitude outcome)	**Description of Assessment (direct or indirect)**	**Where/When the Assessment will be performed**	**Plans for subsequent improvement**
Students will gain knowledge in introductory physics concepts. **(Knowledge outcome)**	Pre/post-test of students, measuring and reporting knowledge gains. **(direct)** Survey of students at end of course. **(indirect)**	Internally developed pre/post in each of PHYS 201 and 202. Multiple choice administered online (pre) and as part of final exam (post) Online survey administered near end of course.	Results will be analyzed and used as a basis for data-driven decisions on improved/new instructional/curricular approaches.
Students will be able to use modern laboratory techniques to measure and analyze experimental data. **(Skills outcome)**	Instructor assessment of students' laboratory techniques and students' written analysis. **(direct)**	In PHYS 202, instructors asked to document this direct assessment based on performance in one, instructor-chosen laboratory experiment.	Results will be analyzed and used as a basis for data-driven decisions on improved/new instructional/curricular approaches.

General Education Courses

The Department of Physics and Astronomy has chosen to assess its General Education offerings by measuring students' performance in a laboratory setting. In the past a final (experimental) exam was given to test the students' knowledge and abilities in designing and conducting an experiment in mechanics. The experimental problem given to the students concerns a simple pendulum. The students must identify variables that may effect the time period of a pendulum (length, mass, amplitude) and investigate to see which one(s) actually have an influence. By analyzing the results, the students attempt to develop an empirical equation that correctly predicts the time period for any simple pendulum.

In addition to this strategy, we propose to have the students perform a similar experiment early in the semester that will serve as a baseline measure or 'pre-test' of the students' abilities. In this way, we hope to measure any gains in student performance. The pre-test will involve the measurement of the acceleration of a cart rolling down an incline and whether such conditions as angle of incline, mass of cart, initial velocity, etc. might affect the value of the cart's acceleration. The students will be asked to make predictions, design experimental tests, and draw conclusions supported by the evidence.

These experimental/laboratory skills tests will be administered in the Physical Science 101 Laboratory sections involving 200-250 students per academic year. The following table might represent a scoring mechanism for these experiments using a 0-10 scale:

Measureable Outcome	Pre-Test Score	Post-Test Score
Identify all testable variables that might affect desired property (cart's acceleration, pendulum's time period)		
Design experimental tests to eliminate (rule out) variables that do not affect the desired property		
From experimental results, identify trends in the data related to variables that do have a significant effect on the desired property, such as direct or inverse relationships.		
Demonstrate proficiency in the data collection and analysis process; accurate measurements and computations		
Identification and minimization of sources of experimental errors, both random and systematic; computation of *percent difference* or *percent error* where appropriate		
Demonstrate ability to draw valid conclusions based on experimental results; recognize strengths and limitations of experimental process		
Where appropriate, develop an empirical equation that describes a particular relationship (such as that between the pendulum's length l and its time period T)	N/A	

The following page contains a sample of the exit survey given to our graduating seniors for the first time. We intend to use this survey, or its equivalent, to learn about these students' post-graduation plans, to get their impression of the department's effectiveness based on their experiences, and to maintain a contact address for each student.

Timestamp	5/1/15	5/1/15	5/1/15	5/1/15	5/1/15	5/2/15	5/4/15	5/5/15
Enter your name	Tiffany Prosser	Christian Todd Rhodes	Aaron Smith	Jason Harrington	Ezekiel Shuler	Ray Austin Freeman	Scott Baldwin	Jonathan Heath
Provide an email address that you will continue to check after graduation.	tcp1123@yahoo.com	christodes@gmail.com	Asrebeldl@yahoo.com	jharrington2955@gmail.com	zekeman26@gmail.com	austin.366@live.com	scott.baldwin75@yahoo.com	jheath8278@gmail.com
What is your major?	Computational Physics	Computational Physics	Health Physics,	Computational Physics	Health Physics	Computational Physics	Computational Physics	Computational Physics,
When did you select this major?	During my first year at	Before starting at FMU	Before starting at FMU	Before starting at FMU	During my first year at	During my first year at	During my first year at	During my first year at
Why did you choose this major?	I like science, math, and computers. Computational physics has it all.	wanted to major in physics and I thought that computational skills would enable me to apply my knowledge in physics in the real world.	I like all sciences and health physics combines all of the sciences and math.	I really wanted to understand vehicle dynamics. I have a book that has sat on a shelf since 1996 because I could not read it. Now I can.	I enjoyed the application and practicality othe major.	I developed an interest in this major by attending the Computational Physics talks given by the faculty.	After talking to Dr. Smith during the summer I changed from CET to comp physics.	Physics because it involved two things I enjoyed: programming and mathematics. Also, physics offered interesting concepts and problem
Are you graduating with any minors? If so, what are they?	Mathematics	Mathematics	No minor	Mathematics	Mathematics, Chemistry	Mathematics	Mathematics	No minor
Did you take any astronomy classes? If so, which ones?	Astronomy, ASTR 202 - Solar system Astronomy, ASTR 203 - Observational Astronomy	ASTR 202 - Solar system Astronomy		ASTR 201 - Introduction to Astronomy, ASTR 202 - Solar system Astronomy				Astronomy, ASTR 202 - Solar system Astronomy, ASTR 203 - Observational Astronomy
How many semesters did you spend enrolled as a student at FMU?	8	8	8	6	8	6	6	8
What is your current overall FMU GPA?	Between 2.5 and 3.0	3.5 or above	3.5 or above	3.5 or above	3.5 or above	Between 3.0 and 3.5	Between 2.5 and 3.0	3.5 or above
How many summer internships did you complete?	0	0	1	1	1	0	2	0
If you completed a summer internship, please list your employer.		through the Palmetto Academy funded by the NASA Space Grant	V.C. Summer Nuclear Power Station	ESAB Cutting Systems	Savannah River Site		AA body builders Ervin engineering	
How many summer research experiences did you complete?	0	1	0	0	1	0	0	3
If you completed a summer research experience, please list where you performed this research.		The Citadel in Charleston, SC			Francis Marion University			Clemson University; LSU; CCT, LSU
Assess your level of content knowledge in your major.	Fairly knowledgeable	Fairly knowledgeable	Very knowledgeable	Fairly knowledgeable	Very knowledgeable	Fairly knowledgeable	Very knowledgeable	Very knowledgeable
Assess your level of competence with regard to laboratory skills.	Very competent	Very competent	Very competent	Very competent	Very competent	Fairly competent	Very competent	Fairly competent
Assess your level of competence with regard to computational skills.	Very competent	Very competent	Fairly competent	Fairly competent	Fairly competent	Very competent	Fairly competent	Very competent
Assess your level of competence with regard to technical writing.	Fairly competent	Very competent	Fairly competent	Fairly competent	Fairly competent	Very competent	Very competent	Very competent
Assess your level of competence with regard to giving a technical presentation.	Fairly competent	Very competent	Very competent	Not very competent	Very competent	Very competent	Very competent	Very competent
Assess to what extent these skills and this content knowledge have improved as a result of the courses you have taken in your major.	Very large improvement	Very large improvement	Very large improvement	Very large improvement	Very large improvement	Very large improvement	Very large improvement	Very large improvement
Assess the sense of community that you experienced within your major at FMU.	Very good sense of community	Very good sense of community	Very good sense of community	Very good sense of community	Very good sense of community	Very good sense of community	Very good sense of community	Very good sense of community
Discuss what things you think contributed (either positively or negatively) to your sense of community.		Small class sizes contributed to my sense of community. It was not too small, not too big. All the professors knew me by name,etc.	Professors are very approachable and friendly.	With there being so few students and proffesors you get to know everyone. I think that was the biggest thing for me.	Living with Aaron Smith and having almost the same classes everyday was an experience.		Could talk to any of the professors at mostly any time of the day. Always welcoming.	Independent research under Drs. Smith& Bryngelson stimulated collaboration. Also, public outreach with Dr. Myers gave me experience in working with general public.
What do you plan to do after graduation?	Job	Graduate school	Graduate school	Job	Job	Graduate school	Graduate school	Graduate school
Please give additional details about your reponse to the previous question about your plans for after graduation.	I would like to have a job in computer programming or related field.	I hope to get accepted to a graduate school so I can go and get my PhD in physics.	Duke University Masters of Medical Physics	internship, Engineering Research department at Sandia National Labs. I will attend grad school.	Looking for any HP job I can get my hands on. The first one is the hardest to get I've been told.	I will be attending graduate school at USC for Mechanical Engineering.	Doing a summer internship. I'm planning on grad school and if that fails then I'll get a job.	I have been accepted into the physics PhD program at Auburn University.
How well do you think that the courses in your major have prepared you for the next steps (life, career, further education) that you will be taking after college?	Very well	Very well	Very well	Very well	Fairly well	Very well	Very well	Very well
Is there anything that you think could have been done to improve your experience (within your major) at FMU?		No		I think adding Linear Algebra as a required course would be a major step forward.	physics capstone class: More time should have been spend on resumes and less time on a research paper.			I wish a few general educational courses could be dropped for a few specialized courses such as thermodynamics.
If you have any other comments that you would like to share about your experience (within your major) at FMU, please write them below.							Had a great three years.	many physics related trips in order to present or absorb material.

The Colorado Learning Attitudes About Science Survey (CLASS) measures students' self-reported beliefs about physics and their physics courses and how closely these beliefs about physics align with experts' beliefs. The surveys ask students questions about how they learn physics, how physics is related to their everyday lives, and how they think about the discipline of physics. The CLASS survey probes students' attitudes and beliefs and distinguishes those of experts from novices. The CLASS was written to make the statements as clear can concise as possible. Students are asked to respond on Likert-like (5-point agree to disagree) scale to statements such as: "I study physics to learn knowledge that will be useful in life" or "After I study a topic in physics and feel that I understand it, I have difficulty solving problems on the same topic" or "To learn physics, I only need to memorize important questions and definitions."

1: Strongly Disagree

2: Disagree

3: Neutral

4: Agree

5: Strongly Agree

The following page contains data from our first attempt at giving this survey to our graduating seniors. The data table has been 'compressed' to fit comfortably into this document, but does seem to provide useful information about our students' attitudes and beliefs concerning the subject of physics and related problem-solving strategies.

RESULTS OF CLASS SURVEY	EXPERT RESPONSES		% EXPERT RESPONSES (8 students)
Enter your name	EXPERT 1	EXPERT 2	
A significant problem in learning physics is being able to memorize all the information I need to know.	1	2	62.5
When I am solving a physics problem, I try to decide what would be a reasonable value for the answer.	4	5	87.5
I think about the physics I experience in everyday life.	4	5	100
After I study a topic in physics and feel that I understand it, I have difficulty solving problems on the same topic.	1	2	62.5
Knowledge in physics consists of many disconnected topics.	1	2	75
When I solve a physics problem, I locate an equation that uses the variables given in the problem and plug in the values.	1	2	25
There is usually only one correct approach to solving a physics problem.	1	2	100
I am not satisfied until I understand why something works the way it does.	4	5	87.5
I cannot learn physics if the teacher does not explain things well in class.	1	2	37.5
I do not expect physics equations to help my understanding of the ideas; they are just for doing calculations.	1	2	62.5
I study physics to learn knowledge that will be useful in my life outside of school.	4	5	75
If I get stuck on a physics problem on my first try, I usually try to figure out a different way that works.	4	5	75
Nearly everyone is capable of understanding physics if they work at it.	4	5	62.5
Understanding physics basically means being able to recall something you've read or been shown.	1	2	62.5
There could be two different correct values for the answer to a physics problem if I use two different approaches.	1	2	75
To understand physics I discuss it with friends and other students.	4	5	100
I do not spend more than five minutes stuck on a physics problem before giving up or seeking help from someone else.	1	2	87.5
If I don't remember a particular equation needed to solve a problem on an exam, there's nothing much I can do (legally!) to come up with it.	1	2	50
If I want to apply a method used for solving one physics problem to another problem, the problems must involve very similar situations.	1	2	50
In doing a physics problem, if my calculation gives a result very different from what I'd expect, I'd trust the calculation rather than going back through the problem.	1	2	100
In physics, it is important for me to make sense out of formulas before I can use them correctly.	4	5	100
I enjoy solving physics problems.	4	5	87.5
In physics, mathematical formulas express meaningful relationships among measurable quantities.	4	5	87.5
It is important for the government to approve new scientific ideas before they can be widely accepted.	1	2	75
Learning physics changes my ideas about how the world works.	4	5	87.5
To learn physics, I only need to memorize solutions to sample problems.	1	2	100
Reasoning skills used to understand physics can be helpful to me in my everyday life.	4	5	100
Spending a lot of time understanding where formulas come from is a waste of time.	1	2	100

I can usually figure out a way to solve physics problems.	4	5	75
The subject of physics has little relation to what I experience in the real world.	1	2	100
There are times I solve a physics problem more than one way to help my understanding.	4	5	75
To understand physics, I sometimes think about my personal experiences and relate them to the topic being analyzed.	4	5	75
It is possible to explain physics ideas without mathematical formulas.	4	5	37.5
When I solve a physics problem, I explicitly think about which physics ideas apply to the problem.	4	5	87.5
If I get stuck on a physics problem, there is no chance I'll figure it out on my own.	1	2	87.5
When studying physics, I relate the important information to what I already know rather than just memorizing it the way it is presented.	4	5	100