



Physics Department  
College of Arts and Sciences  
University of Puerto Rico  
Mayagüez

# **Physics Department Assessment Plan V4.0**

Prepared by the Committee for Assessment of Outcomes  
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## **Department of Physics Assessment Plan**

### **MISSION**

The mission of the Department of Physics derives from the triple mission of the University of Puerto Rico: Teaching: To educate our students to better understand and explore physical phenomena, to apply critical thinking in posing, analyzing and solving problems, and to maintain high professional standards in pursuing their careers. Research: To sustain and advance research and scholarship in Physics and related disciplines. Service: To promote Physics as a discipline throughout the university, the local school system and the community at large.

### **GRADUATING STUDENT PROFILE**

Approved in September 9, 2004 in a department meeting.

The Physics Department Curriculum aims to develop graduates with the following skills and values:

- Critical thinking and problem solving skills through the scientific method
- A professional who values independent study and being self-taught
- Identification of the physical variables relevant to a physics problem
- Mathematical proficiency
- Identify stages and component areas in breaking-up physical problems
- Mathematical formulation of basic aspects of the contributing factors to a physical problem
- Basic laboratory skills for a methodical and fundamental investigation of physical phenomena
- Good communication skills in Spanish and English
- Computer skills for a systematic and fundamental investigation of physical phenomena
- Awareness of contemporary issues in physics
- Awareness of professional ethics
- Team working skills
- Develop an appreciation for the Arts and Humanities

The Physics Department Curriculum aims to develop graduates conceptually and quantitatively proficient in the following areas:

1. **CLASSICAL MECHANICS** [FISI 3161](#), [FISI 4051](#), [FISI 4052](#)  
Kinematics, Newton's laws, work and energy, linear and non-linear oscillatory motion, rigid body motion, dynamics of systems of particles, central forces and universal gravitation, three-dimensional particle dynamics, Lagrangian and Hamiltonian formalism, noninertial reference frames, fluid dynamics.
2. **ELECTROMAGNETISM** [FISI3162](#), [FISI 4068](#), [FISI 4017](#)  
Electrostatics, currents and DC and AC circuits, magnetic fields in free space, Lorentz force, electromagnetic induction, Maxwell's equations and their applications, electromagnetic waves, magnetic and electric fields in matter.
3. **WAVE PHENOMENA AND OPTICS** [FISI3161](#), [FISI 3162](#), [FISI 4017](#), [FISI 3180](#)  
Wave properties, superposition, interference, diffraction, geometrical optics (e.g. reflection, refraction, mirrors, lenses), polarization, Doppler effect, optical properties of matter.
4. **THERMODYNAMICS AND STATISTICAL MECHANICS** [FISI 3161](#), [FISI 4057](#)  
Laws of thermodynamics, thermodynamic processes, thermodynamic potentials, equations of state, ideal gases, kinetic theory, ensembles, partition functions, statistical concepts and calculation of thermodynamic quantities, thermal expansion and heat transfer.
5. **QUANTUM MECHANICS** [FISI 3162](#), [FISI 4105](#), [FISI 4046](#)  
Study of the Schrödinger equation and its interpretation, properties of the wave function, solutions of the Schrödinger equation in 1,2 and 3 dimensions in different potentials (including square wells, harmonic oscillators, and hydrogenic atoms), spin, angular momentum, introduction to the formalism of quantum mechanics, elementary perturbation theory.
6. **ATOMIC PHYSICS** [FISI 4105](#), [FISI 4046](#)  
Properties of electrons, Bohr model, energy quantization, atomic structure, atomic spectra, selection rules, black-body radiation, x-rays, atoms in electric and magnetic fields.
7. **SPECIAL RELATIVITY** [FISI3162](#), [FISI 3180](#), [FISI4105](#)  
Introductory concepts, time dilation, length contraction, simultaneity, energy and momentum, four-vectors and Lorentz transformation, velocity addition, Doppler effect, metrics, introductory tensor algebra.
8. **LABORATORY METHODS** [FISI3163](#), [FISI 3164](#), [FISI 4049](#), [FISI 4076](#), [FISI 4077](#), [FISI 4996](#), [FISI 4999](#), [METE 4007](#)  
Data and error analysis, instrumentation, radiation detection, counting statistics,

interaction of charged particles with matter, lasers and optical interferometers, dimensional analysis, fundamental applications of probability and statistics.

9. **SPECIALIZED TOPICS** [FISI 4049](#), [FISI 4105](#), [FISI 4996](#), [FISI 4997](#), [FISI4999](#), [FISI 5037](#), [FISI 4135](#), [FISI 4125](#), [FISI 5047](#), [METE 4006](#), [METE 4007](#), [METE 4008](#), [ASTR 4005](#), [ASTR 4006](#), [ASTR 5005](#), [ASTR 5007](#)

*Some graduates of the Physics program may also have additional competence in one or more of the following areas:*

### **Electronics**

**Nuclear and Particle Physics:** nuclear properties, radioactive decay, fission and fusion, reactions, fundamental properties of elementary particles

**Condensed Matter:** crystal structure, x-ray diffraction, thermal properties, electron theory of metals, semiconductors, superconductors

**Meteorology:** the Sun-Earth interaction, atmospheric composition, radiative energy budgets, temperature and moisture fields, clouds and stability, precipitation, pressure and wind generation, weather systems, climatology, air pollution

**Astronomy:** descriptive astronomy, solar system, stellar evolution, elements of cosmology, celestial mechanics, astrophysics, galaxies (properties, types, structures, evolution and interaction), formation of planetary systems, radioastronomy, image processing.

**Laser Physics:** laser operation, laser light characteristics, interaction of radiation with matter, optical resonators, pumping schemes, non-linear optics

**Applied Optics:** radiometry, photometry, optical fibers, wave guides, light detectors, Fourier optics, optical image processing, holography, electro-optics, integrated optics.

### **Mathematical Methods**

### **Computer Applications**

## **RELATION AMONG THE PHYSICS DEPARTMENT AND THE INSTITUTIONAL STUDENT PROFILE**

### ***Institutional Graduating Student Profile***

By the time of their graduation, UPRM students will be able to:

- a. Communicate effectively.
- b. Identify and solve problems, think critically, and synthesize knowledge appropriate to their discipline.
- c. Apply mathematical reasoning skills, scientific inquiry methods, and tools of information technology.
- d. Apply ethical standards.
- e. Recognize the Puerto Rican heritage and interpret contemporary issues.
- f. Appraise the essential values of a democratic society.
- g. Operate in a global context, relate to a societal context, and demonstrate respect for other cultures.
- h. Develop an appreciation for the arts and humanities.
- i. Recognize the need to engage in life-long learning.

### ***Department of Physics Graduating Student Profile***

By the time of their graduation, physics department students will have the following skills, values and knowledge:

1. Critical thinking and problem solving skills through the scientific method
2. A professional who values independent study and being self-taught
3. Identification of physical variables relevant to a physics problem
4. Mathematical proficiency
5. Conceptual and quantitative proficiency in the following areas: Classical Mechanics, Electromagnetism, Wave phenomena and Optics, Thermodynamics and Statistical Mechanics, Quantum Theory, Atomic Physics, Relativity, Laboratory Methods and others (see the department student profile)
6. Identify stages and component areas in breaking-up physical problems
7. Mathematical formulation of basic aspects of the contributing factors to a physical problem
8. Basic laboratory skills for a methodical and fundamental investigation of physical phenomena
9. Good communication skills in Spanish and English
10. Computer skills for a systematic and fundamental investigation of physical phenomena
11. Awareness of contemporary issues in physics
12. Awareness of professional ethics
13. Team working skills
14. Develop an appreciation for the arts and humanities.

## Correlation of the Physics Department with the Institutional Student Profile

Institutional Outcomes	Department Outcomes													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Communicate effectively									✓					
Identify and solve problems, think critically, and synthesize knowledge appropriate to their discipline	✓		✓		✓	✓								
Apply mathematical reasoning skills, scientific inquiry methods, and tools of information technology				✓			✓	✓		✓				
Apply ethical standards												✓		
Recognize the Puerto Rican heritage and interpret contemporary issues												✓		
Appraise the essential values of a democratic society												✓		
Operate in a global context, relate to a societal context, and demonstrate respect for other cultures					✓						✓	✓		
Develop an appreciation for the arts and humanities														✓
Recognize the need to engage in life-long learning		✓												

Adapted from: Biology Department Student Learning Assessment Plan

## Correlation of Courses with Student Profile

Course of Instruction	Student Profile													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
FISI3161	✓	✓	✓	✓	✓									
FISI3162	✓	✓	✓	✓	✓									
FISI3163	✓	✓	✓	✓	✓				✓	✓		✓	✓	
FISI3164	✓	✓	✓	✓	✓				✓	✓		✓	✓	
FISI4105	✓	✓	✓	✓	✓	✓	✓				✓			
FISI4051	✓	✓	✓	✓	✓	✓	✓				✓			
FISI4076	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	
FISI4077	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	
FISI4068	✓	✓	✓	✓	✓	✓	✓	✓						
FISI4052	✓	✓	✓	✓	✓	✓	✓							
FISI4046	✓	✓	✓	✓	✓	✓	✓				✓			
FISI4057	✓	✓	✓	✓	✓	✓	✓				✓			
FISI4125	✓	✓	✓	✓	✓	✓	✓			✓				
FISI4001	✓	✓			✓	✓			✓		✓	✓		
FISI4002	✓	✓			✓	✓			✓		✓	✓		

### \*Courses Outside the Physics Department that contribute to the Student Profile

Areas of Instruction	1	2	3	4	5	6	7	8	9	10	11	12	13	14
CISO/ECON 6cr														✓
HUMA 3111-12 6cr														✓
Comp. Science 3cr											✓			
MATE 25cr				✓										
ESPA/INGL 24cr									✓					
BIOL/QUIM 14cr	✓			✓				✓						

\* Although we will not conduct assessment of these courses, we want to mention their contribution to the student profile.

**ASSESSMENT TOOLS FOR EACH OF THE SKILLS AND VALUES DESCRIBED IN THE STUDENT PROFILE**

<b>SKILLS AND VALUES</b>	<b>ASSESSMENT TOOLS</b>
Critical Thinking	Exams, Quizzes, Course Projects, Laboratory reports, Written and Oral Reports, Homework
Problem Solving Skills	Exams, Quizzes, Course Projects, Laboratory reports, Homework
Identification of physical variables relevant to a physics problem	Exams, Quizzes, Laboratory reports, Homework
Mathematical Proficiency	Exams, Quizzes, Laboratory reports, Homework
Identify stages and component areas in breaking-up physical problems	Exams, Quizzes, Laboratory reports, Homework
Mathematical formulation of basic aspects of the contributing factors to a physical problem	Exams, Quizzes, Laboratory reports, Homework
Basic laboratory skills	Laboratory Reports
Good communication skills in Spanish and English	Oral and Written presentations, Laboratory reports
Computer skills	Laboratory Reports
Awareness of contemporary issues in physics	Exams, Written and Oral Reports (Seminars)
Awareness of professional ethics	Ethics Assessment Form (to be developed)
Team working skills	Teamwork Assessment form (to be developed)
Conceptual and quantitative proficiency in the following areas: Classical Mechanics, Electromagnetism, Wave phenomena and Optics, Thermodynamics and Statistical Mechanics, Quantum Theory, Atomic Physics, Relativity, Laboratory Methods and others	Exams, Quizzes, Course Projects, Laboratory reports, Written and Oral Reports, Homework, Course Portfolio, Course Syllabus. Students GPA analysis.

Adapted from: Biology Department Student Learning Assessment Plan

**ASSESSMENT TOOLS & TIMING**

<b>ASSESSMENT TOOLS</b>	<b>Timing (Person responsible)</b>
Laboratory Reports ( <i>copies</i> )	During most Laboratory Courses (Lab Instructors)
Exams, Quizzes, Homework, course projects ( <i>copies</i> )	Throughout each semester (all Professors/Instructors)
Written Report Assessment	Whenever required whether lab or lecture (undergraduate seminar course, labs, etc) (Professors/Instructors)
Oral Presentation Assessment	Whenever required whether lab or lecture (undergraduate seminar course, labs, etc) (Professors/Instructors)
Teamwork Assessment Form	At end of any semester where work is performed in groups (Professors/Instructors)
Ethics Integration Assessment Form	At end of any semester where ethics is discussed (professors/instructors)
Student’s evaluation of Teaching Assistants	At end of every Laboratory Course (all students)
Student’s Evaluation of Teaching (UPRM Form)	After 10 weeks of each semester (all students)
Freshman Entry Questionnaire	During Freshman Welcoming Week (Associate Department Director)

Adapted from: Biology Department Student Learning Assessment Plan

**OTHER ASSESSMENT TOOLS**

<b>ASSESSMENT TOOLS</b>	<b>Timing (Person responsible)</b>
*Student Program Assessment	When finishing program requirements (Graduation Candidates)
*Student Research Performance Assessment Form	Whenever the student performs research (Research Advisor)
*Employer Assessment Form	Sent to the Employer by department. The employer will assess the student’s academic preparation. The Employer may also provide insight about skills and values the students in general should have in order to successfully compete in the market place. (The employer)
*Alumni Program Assessment Form	Continuously (Department)

\* To be developed and approved by Faculty

## **ACTIONS TO BE TAKEN ACCORDING TO ASSESSMENT RESULTS**

The results from the course assessment will be used to

- develop strategies to improve the teaching-learning process
- revise course content and level
- revise course syllabi
- revise departmental strategic plan
- include skills and values previously excluded into curriculum
- modify the curriculum