

## **Program and Student Learning Outcomes for Physics Major and Minor Plans**

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Undergraduates who successfully complete the physics major plans will have gained knowledge, skills, and proficiency appropriate to their degree in the 5 key topic-areas identified in the program's *Mission Statement – classical mechanics, electricity and magnetism, thermal and statistical physics, modern physics including quantum mechanics and relativity, and experimental methods*. In addition to these core subjects, students will gain breadth of knowledge in several more advanced or specialty areas important for graduate study and careers by completing the upper-level electives required in each plan. Within the specific subjects of instruction covered in these plans, student learning outcomes will be assessed in the program's 7 general learning-outcome categories: *basic laws of physics, critical thinking, problem solving, laboratory skills, development of physics, contemporary areas of physics, and written and oral communication* (see descriptions below in [Attachment 1](#), and the link "[Curriculum Mapping](#)" on this webpage.) The proficiency of learning will be assessed by students passing the required core and elective courses in each physics major or minor plan as described in the next paragraph. The credit requirements for the plans, the available physics elective courses, and the curriculum mapping of the courses into the program's 7 learning-outcome categories are listed below in [Attachments 2, 3, and 4](#), respectively. (For more details, link also to "[Physics Undergraduate Handbook](#)".)

To be accepted into one of the physics major or minor plans ([Attachment 2](#)), students must achieve a GPA  $\geq 2.0$  in the 5 prerequisite courses: General Physics I, II, and II laboratory, and Calculus I, and II. Majors in the three B.S. programs who graduate with a GPA of  $\geq 3.0$  in the required core and elective courses achieve the proficiency to successfully pursue Ph.D. or Masters study in their respective physics fields for future industrial, government, and academic careers involving research, advanced development, or higher education. Majors in the two B.A. plans who achieve a GPA  $\geq 3.0$  are prepared to successfully pursue a broader range of physics and teaching careers, and for related graduate study (Ph.D. or Masters level) as appropriate to their career direction. B.S. and B.A. majors who graduate with a GPA of  $< 3.0$  in the core and elective courses are expected to have a proficiency adequate for physics careers in industry or government at the baccalaureate entrance level, or to pursue a Masters toward non-academic employment. Students who complete the Physics Minor have sufficient background to pursue non-physics careers or graduate studies that rely on a general knowledge of physics principles.

Program learning outcomes will be assessed using student performance on faculty-administered rubric exam or quiz questions that test the 7 general learning-outcome categories identified above. The percentage of students achieving proficiency ratings on these questions corresponding to  $\geq$  C-level work for 100/200-level courses, or to  $\geq$  B-level work for 300/400-level courses, will be compared against the instructor's expected benchmarks in each course. (These proficiencies are set by the standards needed to be accepted as a physics major, and the standards desirable to pursue Ph.D. study, respectively.) Faculty will supply this data for each course as the **x-values** in the Rubric Results column of the course's Assessment Implementation table (see "[Course Rubric-Qs data](#)" on this web-page.) The rubric results will be compiled and analyzed cumulatively for each of the general learning outcomes to assess the effectiveness of the Department in achieving its yearly and 4-year learning and program goals for undergraduate education. (See "[Prog. Rubric-Qs results; Program Analysis graphs](#)" on this webpage.)

Assessment of the physics program will be implemented further by means of exit surveys conducted with graduating seniors. (See the link "[Exit Interview data](#)" on this webpage.) Survey results on graduate school admission, employment, awards and scholarships, Majors and Minors completed, receipt of Dept. or Latin honors, research conducted, GPA achieved, and GRE scores (optionally supplied) will be cross-correlated with the rubric-based analysis.

The Physics Undergraduate Studies Comm. will review these assessments yearly to allow timely program improvements by the Dept. (Link to "[Program Assessment Yearly Summary](#)" on this webpage.)

### **Attachment 1: General Learning-Outcome Categories for Physics Undergraduate Program**

1. The basic laws of physics, their corollaries, and comprehension of how they can be applied to explain specific natural phenomena within the five key topic-areas\* as described in the mission statement of the physics undergraduate program.
2. Use of critical thinking, hypothesis building, and application of the scientific method to physics concepts, theoretical models and calculations, and laboratory experimentation.
3. Problem solving skills and relevant mathematical methods to approach, conceptualize, and achieve analytical or numerical solutions to physics problems within important sub-categories of the five topic-areas\*.
4. Laboratory skills and exposure to a variety of important experiments at appropriate levels that illustrate phenomena discussed in the lecture classes. Instrumentation and experimental techniques; methods for quantitative analysis of data and measurement uncertainty.
5. General knowledge of the development of physics and the nature of scientific inquiry, particularly the progression from classical physics to the modern physics ideas of quantum mechanics, statistical mechanics, and relativity.
6. Contemporary areas of physics inquiry as introduced in upper-level physics and interdisciplinary elective courses, as well as in faculty-mentored undergraduate research available to all majors who seek this experience.
7. Written and oral communication skills for dissemination of scientific results in report, article, or oral presentation formats; standard citation methods; ethics in science and scholarship and its importance to scientific inquiry and professionalism.

(\*key-topic areas as given in the Mission Statement of the physics undergraduate program are:

- i*) classical mechanics; *ii*) electricity and magnetism; *iii*) thermal and statistical physics;
- iv*) modern physics including quantum mechanics and relativity; *v*) experimental methods.)

## **Attachment 2: Credit Requirements for Physics Major and Minor Plans**

(Note: In order to graduate with a baccalaureate degree, students must pass a total of 120 credits, including those needed to satisfy the General Education course requirements.)

*B.S. in Physics:* 51 credits in physics (including 9 credits of upper-level electives)  
34 credits in technical subjects outside of physics

*B.A. in Physics:* 46 credits in physics (including 9 credits of upper-level electives)  
26 credits in technical subjects outside of physics

*B.A. in Physics with teaching of science concentrations:*  
57-61 credits in physics, chemistry, mathematics  
(including 4-2 credits of upper-level physics electives)  
19 credits in education

*B.S. in Mathematical Physics:*  
40 credits in physics (including 3 credits of upper-level electives)  
38 credits in mathematics (including 3 credits of upper-level electives)

*B.S. in Computational Physics:*  
37 credits in physics  
27-30 credits in computer science  
23 credits in mathematics (including 3 credits of upper-level electives)

*Minor in Physics:*  
25 credits in physics (including 3 credits of upper-level electives)  
8 credits in mathematics

## **Attachment 3: 300/400-Level Elective Courses Available to Physics Majors and Minors**

(Students may choose from among the following 3-credit courses depending on the requirements of the physics major or minor plans in which they are enrolled.)

PHY 302 Intermediate Mechanics II  
PHY 402 Modern Physics II  
PHY 404 Electricity and Magnetism II  
PHY 406 Thermal and Statistical Physics II  
PHY 407 or PHY 408 Advanced Laboratory  
PHY 410 or PHY 411 Computational Physics I or II  
PHY 412 Nuclear and Particle Physics  
PHY 413 Electronics  
PHY 425 Intermediate Optics  
PHY 431 Introduction to Mathematical Physics I  
PHY 434 Solid State Physics  
One 300 or 400 level course in another technical subject