Form E-1-A for Boston College Core Curriculum

Department/Program __PHYSICS_____ **May 2023**

1) **Have formal learning outcomes for the department's Core courses been developed? What are they?** (What specific sets of skills and knowledge does the department expect students completing its Core courses to have acquired?)

   The Department of Physics Core courses share with the university's Natural Science Core the same desired outcomes, namely that at the completion of a Core course students will have:

   a) expanded their understanding of the principles, body of knowledge, and investigative strategies that comprise physics and its technological applications;
   b) developed a scientific literacy that will promote curiosity, respect for the scientific method, and general awareness of the limitations of scientific conclusions;
   c) recognized the role of scientific discovery, past, present, and future, in interrelated concerns such as human health, societal well-being, and planetary sustainability; and
   d) appreciated the role of physics in defining their relationship with the natural world and their position within the cosmos.

   These outcomes are accomplished through presentation of fundamental principles in classical and/or quantum principles, including logical and mathematical analysis techniques (at a level appropriate for the course) and historical background into the investigations that led to the development of those principles. All courses include connections of physics principles and current physics research to the development of solutions to problems in healthcare, protecting the environment, and overall societal well-being.

2) **Where are these learning outcomes published? Be specific.** (Where are the department's expected learning outcomes for its Core courses accessible: on the web, in the catalog, or in your department handouts?)

   The complete list of outcomes is published on the Department of Physics "Undergraduate Program" www.bc.edu/content/bc-web/schools/mcas/departments/physics/undergraduate.html

3) **Other than GPA, what data/evidence is used to determine whether students have achieved the stated outcomes for the Core requirement?** (What evidence and analytical approaches do you use to assess which of the student learning outcomes have been achieved more or less well?)

   The data differ depending on the nature of the Core course with respect to amount of rigor and mathematical detail. Student evaluations are reviewed for all Core courses. In the problem-solving based Core courses that cover classical mechanics (PHYS1500, PHYS2100, and PHYS2200), the department administers "Force Concept Inventory"/Mechanics Baseline test at the beginning and end of the semester to assess student learning over the semester.

4) **Who interprets the evidence? What is the process?** (Who in the department is responsible for interpreting the data and making recommendations for curriculum or assignment changes if appropriate? When does this occur?)

   All physics faculty members who teach Core courses participate in interpreting the evidence, for example, by administering and analyzing results from the Force Concept Inventory exams. However, it is the responsibility of the Undergraduate Affairs Committee (UAC) with the department Chairperson to coordinate the process, evaluating and analyzing departmental data. That committee reports to the physics faculty as a whole and receives their input. The UAC will (a) work with instructors to develop

specific ways to better meet program goals and address deficiencies and (b) make recommendations to the Chairperson and/or faculty for changes in the curriculum.

5) **What were the assessment results and what changes have been made as a result of using this data/evidence?** (What were the major assessment findings? Have there been any recent changes to your curriculum or program? How did the assessment data contribute to those changes?)

The Department of Physics offers the following Core two-courses:

PHYS1100-1 (3 credits) is a two-semester course sequence for students interested in the non-technical aspects of astronomy and cosmology
PHYS1400 (3 credits) takes an integrated approach to the philosophy, history, and quantitative reasoning of physics.
PHYS1500-1 (3 credits) is algebra-based and for non-science majors, and includes non-science major students in the Pre-Health Program (majority of students are neuroscience majors).
PHYS2100-1 (4 credits) is calculus-based course sequence for Biology majors and students in the Pre-Health Program but not in the physical sciences (two sections typically with total enrollment of about 200 students).
PHYS2200-1 (4 credits) is a calculus-based course sequence. The fall semester has two sections, PHYS2200.01 is for physical science, math, computer science, and E&ES majors, while PHYS2200.02 is recommended for Human Centered Engineering majors. PHYS2201 has only one section because HCE majors are not required to take the 2nd semester of physics.

Results/changes:
Student feedback regarding PHYS1400 has varied year-to-year, and we are working with the instructor to optimize the content, presentation, and learning assessment of the material.

The FCI exam 'normalized g-scores' for core introductory calculus-based courses were excellent, at the very high end of the national range for lecture courses (average near 0.3, typical range 0.25 – 0.35*), and no course content changes were implemented.
PHYS2100: g = 0.49
PHYS2200.01: g = 0.44
PHYS2200.02: g = 0.39

*For example see A. Pawl, Physics Education Research Conference 2015 p. 251 (2015) DOI:10.1119/perc.2015.pr.058

Students noted in class evaluations and discussions with instructors that the PHYS2200 courses lacked connection to current applications and research. The courses were modified to include at least 5 or 6 30-minute guest presentations regarding current physics research. Example lectures included topics such as modeling weather patterns, quantum sensors for opioid detection in wastewater, the use of nanoparticles in cancer therapy, and the use of elementary particles (muons) generated at large international facilities to probe novel magnetic materials. Links to introductory physics topics were emphasized, and student feedback was very positive.

6) **Date of the most recent program review.** (Your latest comprehensive departmental self-study and external review)

After an internal review of our undergraduate curriculum in 2019 – 2021 (COVID interrupted) we proposed, and had approved by the EPC and Board of Trustees in June 2022, a new BS degree program in Applied Physics.

Last external review: December 2009