Form E-1-A for Boston College Core Curriculum

Department/Program __PHYSICS & APPLIED PHYSICS_____ May 2024

1) **Have formal learning outcomes for the department's Core courses been developed? What are they?**

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.**

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?**

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 ('FCI') at the beginning and end of the semester to assess student learning over the semester.

New: This year we introduced a new learning metric, the Brief Electricity and Magnetism Assessment* ('BEMA') in our core/major course PHYS2201.
*See Ding et al., Phys. Rev. ST Phys. Educ. Res. 2, 010105 (2006)

4) **Who interprets the evidence? What is the process?**

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?**

The Department of Physics offered the following Core course/sequences in AY2023-4:

PHYS1100-1 (3 credits each) 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 each) is algebra-based and for non-science majors, and includes students in the Pre-Health Program who are not required to take calculus-based physics; the majority of students are neuroscience majors.
PHYS2100-1 (4 credits each) is calculus-based course sequence for Biology majors and students in the Pre-Health Program but not in the physical sciences (2 sections typically with enrollment of about 200 total).
PHYS2200-1 (4 credits each) 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:

a. Student evaluations for PHYS1100 were exceptionally poor, and the instructor was replaced for the second semester of the sequence, PHYS1101.

b. Previous student evaluations of PHYS1400 were poor, and the instructor met with the department chair to develop strategies to improve the course experience for students. The evaluations improved greatly, e.g., the mean overall course rating increased from 2.00 in 2022F to 3.74 in 2023F.

c. The FCI and BEMA exams 'normalized average of gains' score were at the 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.

FCI

PHYS2100.01:	g = 0.38
PHYS2100.02	g = 0.33
PHYS2200.01:	g = 0.43
PHYS2200.02:	Not applied this year (miscommunication with new instructor)

BEMA

PHYS2201	g = 0.40

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

d. Student comments in PHYS2200 suggested that introductory courses lacked connection to current applications and research. However, students also requested more time for in-class problem solving. While we continued providing 30-minute guest presentations in PHYS2200 by faculty and graduate students regarding current physics research in our department, the number of presentations was less this year to create more problem-solving time, and to reduce 'saturation' by too many guest lectures.

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

Internal review: 2019 – 2021, leading to a new BS degree program in Applied Physics.

Last external review: December 2009