Annual Departmental Assessment Report – submitted June 2021

Department or Program: ***Physics***
Academic Year of Report: ***2020***
Department Contact Person for Assessment: ***Scott Fisher, Director of Undergraduate Studies***

Section 1: Learning Objectives Assessed for this Report

Desired broad outcomes for UO physics baccalaureate recipients include:

1. Knowledge of principles and concepts for specific core subject areas listed below.
2. Ability to apply principles and concepts to analyze problems within specific core areas.
3. Capability with quantitative methods appropriate for the core areas.
4. Ability to analyze and interpret quantitative results.
5. Experience with integration of concepts: analysis of complex problems cutting across multiple core areas.
6. Ability to collect and appropriately analyze data working independently and in collaboration with others (experimentation; data collection, reduction and analysis; model-based computation including simulations and inversion of observations; and literature research using basic and state-of-the-art technology).
7. Ability to communicate Physics concepts and research results orally and in writing.
8. Familiarity with current developments in physics.

To achieve these outcomes, the undergraduate major curriculum requires coursework with nationally-standard coverage of the core subject areas. As specific content objectives for the core areas, students who complete the department-based courses should:

1. have a working knowledge of classical mechanics and its application to "standard" problems such as central forces and rotational dynamics;
2. understand the principles of special relativity and have a working knowledge of its application to the mechanics of particles;
3. have a working knowledge of basic electrostatics, electrodynamics, and magnetism leading to the development of Maxwell's equations;
4. have a working knowledge of geometrical and physical optics;
5. have a working knowledge of electrical circuits and their applications;
6. have a working knowledge of basic thermodynamic principles and the relation of statistical mechanics to them;
7. have a working knowledge of elementary quantum mechanics and its application to the explanation of atomic structure and atomic spectroscopy;
8. have basic skills in laboratory practice including a working knowledge of data analysis, computer interfacing, scientific computing, and graphical presentation of results.

In 2019 we re-tooled the PHYS major in a significant way. In 2020 we monitored the reactions of the students to these changes. The changes to the major were to:

- remove the previous “tracks” system
- broaden the choice of upper-division PHYS classes available to majors
- re-assess the upper-division requirements for the major

In the new system the first two years of the major remain unchanged. In the upper-division part of the major, the students are presented with a menu of all currently available PHYS classes and they can choose their own path through them. The majors are required to take a total of **30 upper-division credits, of which at least 6 (and a maximum of 12) must be in designated lab classes.**

In 2020 the department developed new "flight paths" through the major – which are akin to the older tracks. However – we want to note that these are fundamentally different since they are not required paths through the major. They are only to help guide a student into broad areas of study. The contents of the two flight paths are:

*Recommended Upper Division Courses for **Graduate School***

PHYS 411 -- Classical Mechanics (4 credits)
PHYS 412 / 413 -- Electricity & Magnetism (8 credits)
PHYS 414 / 415 -- Quantum Mechanics (8 credits)
PHYS 417 -- Electromagnetism (4 credits)
PHYS 422 -- Topics in Quantum Physics (4 credits)
PHYS 481/PHYS 410 -- Design of Experiments/Scientific Computation (4 credits)
Total Credits: 32 (non-lab)

Lab component (some combination of these need to add up to 6 credits)

PHYS 401 -- PI Sponsored Research
PHYS 431 / 432 -- Analog / Digital Electronics
PHYS 49X -- Advanced Projects Lab

For Graduate School oriented students, we also recommend taking the MATH courses:

Linear Algebra (MATH 342)
Partial Differential Equations & Fourier Analysis (MATH 421M)
Functions of a Complex Variable (MATH 411)

*Recommended Upper Division Courses for **Public / Private Sector***

PHYS 411 -- Classical Mechanics (4 credits)
PHYS 412 / 413 -- Electricity & Magnetism (8 credits)
PHYS 414 -- Quantum Mechanics (4 credits)
PHYS 424 -- Classical Optics (4 credits)
PHYS 481/PHYS 410 -- Design of Experiments/Scientific Computation (4 credits)
Total Credits: 24 (non-lab)

Lab component (at least 6 and we recommend 12 credits in total)

PHYS 425 -- Modern Optics (4 credits)
PHYS 401 -- PI Sponsored Research (variable credit)
PHYS 431 / 432 -- Analog / Digital Electronics (8 credits)
PHYS 49X -- Advanced Projects Lab (variable credit)

Additional – and more specialized – classes that meet the upper division credit requirement offered in specific terms. The majors are requested to keep a close eye on which of these are offered each term. The specialized courses are listed below:

Topics in Astrophysics (PHYS 321)
Biological Physics (PHYS 362)
Mathematical Methods (PHYS 410)
Writing Science (PHYS 410)
Scientific Computation (PHYS 410)
Science and Policy Interface (PHYS 410)
Space Physics (PHYS 410)
Topics in Quantum Physics (PHYS 417)
Electromagnetism (PHYS 422)
Classical Optics (PHYS 424)

Courses that count towards the lab credit requirement:

* Modern Optics Lab (PHYS 425)
* Analog Electronics / Digital Electronics (PHYS 431 / 432)
* Advanced Projects Lab (PHYS 49X)
* Research (PHYS 401)
* Various PHYS 410s (see UG Adviser)
* Design of Experiments (PHYS 481)

All majors that started in Fall 2019 (and after) will be held to the new requirements. The department has also allowed any student that was previously enrolled in the major to move onto the new 'no tracks' system if they desire.

Section 2: Assessment Activities

Given the overall situation in 2020, the department did not carry out any formal assessment activities. However – we did continue to gather data on how the majors are progressing through the new 'no tracks' system. Since its inception in Fall 2019 we have now had a full academic year of incoming majors in this system. We had several students "opt in" to the new system, it seems that the new system has been embraced by the PHYS majors as seen by the number of PHYS majors that followed the new major requirement for graduation in Spring 2021. In our graduating class of 22 majors the distribution was:

- '30 credits' requirement: 7
- Applied Track: 7
- Pure Track: 4
- PHYS minor: 4

It is the goal of the Curriculum committee to perform more formal assessment activities in the coming academic year. However – we would like to solicit assistance with this from other departments and/or UO staff.

Section 3: Actions Taken Based on Assessment Analysis

The direct actions taken this year were all related to the new 'no tracks' system. During this first year we carefully monitored the reactions of the students to the new system and provided extra support to those who considered changing to the new system. Overall, we have had positive feedback from the PHYS majors. However, a few students did note that the information about the new system was at first difficult to find and understand. This has ben rectified by updating the PHYS majors document and making sure that document was sent to all PHYS majors.

Section 4: Other Efforts to Improve the Student Educational Experience

The department has been continually revising and improving our efforts to teach science literacy to non-majors, in concert with the Science Literacy Program, focusing on evidence-based practices that promote assessment, inclusion, and active learning. In particular, the faculty that are teaching our high-enrollment classes are incorporating more active learning techniques into their teaching. As in previous years, exemplary examples of this are in our senior-level Electricity $ magnetism classes (PHYS 412, 413, 422) as well as in our General Education classes like ASTR 122 and PHYS 153.

In 2019 we started piloting a new class for some of our 2nd year majors. In 2020 this class has evolved into "PHYS 299 – The Culture and Careers of Physics". This 1-credit (optional) class is meant for incoming Freshman PHYS majors to be taken in their 1st term at UO. The overarching goals of the class are:

- Cohort building by introduce the students to each other in a low stakes environment
- Broaden the student experience to diversity and inclusion topics related to Physics
- Reinforce the necessary mathematical and analysis skills needed to succeed in our core PHYS classes

PHYS 299 is based on a vetted and well received class that was formerly part of the NorthStar Project. It will be offered for the first time in Fall 2021.

Based on developments at UO as well as trends within the Physics community, in 2020 the department dove into the creation of a new concentration with the major centered on Computational Physics.

Computational Physics and the Physics Path though the new Data Science Major
In 2020 the department ramped up its development of computational physics classes and its engagement with the UO Data Science major. Dr. Ben Farr is leading the creation of a Physics concentration for the new Data Science major. He is also the leader of a small team of PHYS faculty that are developing new classes that concentrate on the computational aspects of modern physics. We hope that the first of these classes with be offered (likely as a PHYS 410 class) sometime this academic year.

Section 5: Plans for Next Year

In the 2021 academic year the Physics curriculum committee will continue assess the functionality of the core introductory curriculum presented in the Physics 25X and 35X sequences. The goal of this assessment will be a potential reorganization of the curriculum in order to bring students more rapidly

to the point at which they can begin to take the courses described above as central to the Physics major. One significant consideration is to potentially delay the start of the "PHYS 250s" till Winter term of each year. This will give PHYS majors that need a term of remedial MATH a term to get prepared for this initial sequence in the major. Through analysis of retention data, the department has recognized that this "first term barrier" seems to be a significant place we lose majors, we hope that the delay of the sequence will help plug this leak in the pipeline.

We (the curriculum committee) attempted to shift the start of these classes in 2020, however, the initiative failed at a vote of the entire PHYS faculty. We plan on re-tooling the proposal and resubmitting it for a vote in 2021.