

Physics Major Curriculum Change Request July 2023

Request

The Department of Physics is requesting to remove the current focuses from the undergraduate major program. Note: a focus is a type of subplan that is required but not transcribed.

History

The undergraduate physics major has contained focuses for several decades. Under quarters there were six focuses:

- A – Advanced Physics
- B – Physical, Mathematical, and Engineering Sciences
- C – Biophysics and Biomedical Physics
- D – Pre-Med
- E – Secondary Education Physics
- F – Personalized

All students in the Physics major were required to complete a specific set of physics and math courses which were referred to as the “core requirements”. In addition to the core requirements, students would take additional electives for the specific focus they were pursuing.

During the quarter to semester transition, focuses B, C, and F were combined in to one focus called Applied Physics. We also removed the A-E designations as students often saw Focus A as “the best” and Focus F as “the worst” due to the correlation of the A-E grading scale. Therefore, the focuses currently exist under semesters as:

- Advanced Physics – for students who will pursue a Physics PhD
- Life Sciences – for students who plan to go to medical, dentistry, veterinary school, etc.
- Physics Education – for students who plan to teach at the K-12 level
- Applied Physics – for students going into full-time employment after graduating or going to graduate school for a field outside of physics

The current focuses are not indicated on the student’s transcript, and they exist purely to help students choose electives that are appropriate for their post-graduation plans.

Rationale

Focuses negatively affecting student decision-making

Unfortunately, even with the renaming of the focuses during the quarter to semester transition, students still view the Advanced Physics Focus as the best since it “sounds better” or “more impressive” than the other focuses. We’ve talked to many students who feel pressured to pursue the Advanced Focus even if they have no plans to attend physics graduate school. Only after they are assured that no one will be able to see on their diploma or transcript which physics focus they completed, do they feel comfortable with pursuing a different focus. Although we state this during both freshman survey and the sophomore

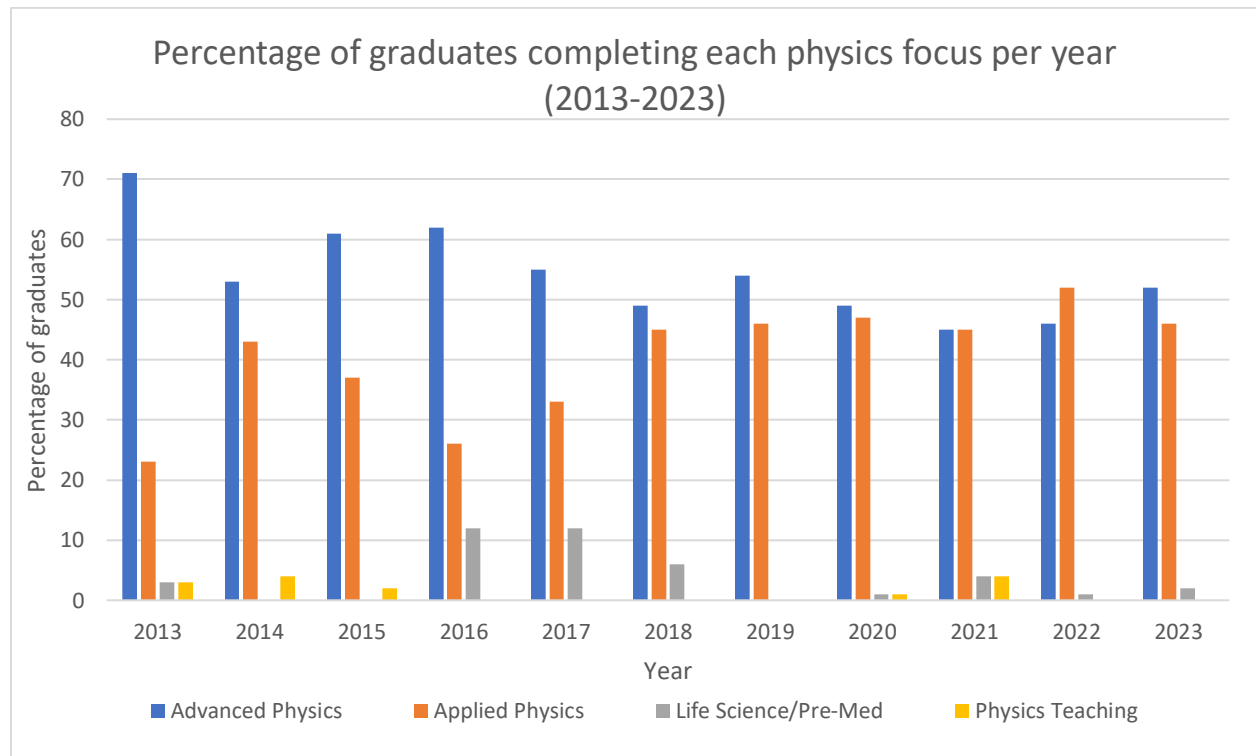
seminar course, students seem to need a one-on-one discussion about this before they feel like they have permission to have more flexibility with their curriculum.

Lack of Flexibility

We often see a scenario where a junior or senior student wants flexibility to take a course that is not prescribed by the focus they have been pursuing. One example is a senior who has been pursuing the Advanced Physics Focus who wants to take a course in a different department (usually engineering, math, or astronomy) that was recommended to them by their research advisor or other faculty mentor. They ask if they can take this recommended course in place of a required course for the Advanced Physics Focus. The response is “no” since only physics courses can count toward the Advanced Physics Focus, but we can switch the student to the Applied Physics Focus which would allow for the flexibility. Usually in that situation many students feel uncomfortable making that change since they’ve been pursuing the Advanced Physics Focus for several years so such students will often forgo the recommended elective in order to stay on their original academic plan.

Removing the focuses will allow students to make elective decisions based on both their career plans and on the recommendations of their academic advisors and faculty mentors and they would not have to adhere to a black-and-white, pre-prescribed curriculum.

Students desire the flexibility that is already allowed by the Applied Physics Focus. This is evident by 1. conversations had with students and 2. the rising percentage of students graduating from the Applied Physics Focus since the start of the semester system.



Confusion about Degree Audit Report and Name of Major

It is not common but occasionally we will talk to a student who thinks their major is “Applied Physics” or “Advanced Physics” and they are disheartened to learn that their major is simply “Physics”. Additionally, students sometimes experience confusion while looking at their degree audit report as it shows all four focuses until one is fully completed. This proposed change will eliminate such confusion.

Proposed change in line with other institutions

We reviewed the degree requirements for Physics majors at other universities such as the University of Illinois, University of Michigan, Michigan State, Penn State, UCLA, University of Wisconsin, Purdue, Cal Tech, and Case Western Reserve. Most did not contain tracks or focuses, but did require a certain number of electives, like what our new proposed structure will be.

Only two schools we reviewed had a similar degree structure to what we currently have in place.

Proposed New Curriculum

The core set of courses – those that are required for all students regardless of focus – will not change. See Appendix A for the current requirements. The core currently, and will continue, to consist of:

Required prerequisite courses (26-32 hours)

- Physics 1250, 1250H, 1260, or 1270 – Introductory Physics I (5 hours)
- Physics 1251, 1251H, 1261, or 1271 – Introductory Physics II (5 hours)
- Programming requirement: CSE 1222 or CSE 1223 or CSE 1224 or Astronomy 1221 (3 hours)
- Calculus (one of the below sequences; 10-14 hours)
 - Math 1151-1152-2153
 - Math 1151-1172-2173 (for those switching from UENG to UASC)
 - Math 1181H-2182H
 - Math 4181H-4182H
- Differential equations (choose one): Math 2255, 2415, 5520H, or 2174

Required major courses (41-43 hours)

- Physics 2095 – Physics Seminar (1 hour)
- Physics 2300-2301 – Intermediate Mechanics I & II (8 hours)
- Physics 3700 – Experimental Physics Instrumentation and Data Analysis Lab (3 hours)
- Physics 5400 – Intermediate Electricity and Magnetism (4 hours)
- Physics 5500 – Quantum Mechanics (4 hours)
- Physics 5700 – Advanced Physics Laboratory (3 hours)
- Physics Elective (choose one): Physics 3470, 5261, 5300, 5401H, 5501, 5501H, 5600, or 5680 (if not taken as a 3rd lab)
- 3rd Physics Lab (choose one of the below)
 - Physics 4700: Introductory Electronics for Physicists (3 hours)
 - Physics 5810: Computational Physics (4 hours)
 - Physics 5680: Big Data Analytics in Physics (3 hours)
- 12 hours of Career Electives

Students will be required to take at least 12 credit hours of Career Electives that are appropriate for their goals, interests, and career plans. As is currently the case with the Applied Physics Focus, the elective hours can come from outside of the department.

Students will be provided with guidelines as to what can qualify as an elective. Those guidelines are:

- Cannot already be required by the physics major program (e.g. a required prerequisite or part of the core)
- Cannot double count as a General Education course
- Must be graded as opposed to pass/non-pass (with the exception of SP20 and AU20) or satisfactory/unsatisfactory
- Must be 2000 level or above
- Seminars and undergraduate research courses cannot count

Students will be provided with guidance on which courses can count as a Career Elective. Possible electives include:

Chemistry 2510 & 2520 – Organic Chemistry I & II

Chemistry 2540 & 2550 – Organic Chemistry Laboratory I & II

Communication 2110 – Principles of Effective Public Speaking

Communication 3240 – Science Communication

Communication 3404 – Media Law and Ethics

CSE 2221 – Software 1

ECE 2020 – Introduction to Analog Systems and Circuits

ECE 3030 – Semiconductor Electronic Devices

ECE 5037 – Solid State Electronics and Photonics Laboratory

ECE 5537 – Semiconductor Device Characterization and Modeling Lab

English 3304 – Business and Professional Writing

English 3305 – Technical Writing

English 3405 – Professional Communication

Geography 5900 – Weather, Climate, and Global Warming

Industrial and Systems Engineering 2040: Engineering Economics

Math 2568 – Linear Algebra

Math 4551 – Vector Analysis

Math 4552 – Complex Analysis

Math 4580 & 4581 – Abstract Algebra I & II

Math 5756 & 5757 – Mathematical Methods in Relativity Theory I & II

ME 3500 – Engineering Thermal Sciences

MSE 2010 – Introduction to Engineering Materials

Nuclear Engineering 4505 – Introduction to Nuclear Engineering

Nuclear Engineering 5606 – Nuclear Reactor Systems

Physics 5300 – Theoretical Mechanics

Physics 5401H – Honors Electromagnetism II

Physics 5501 or 5501H – Quantum Mechanics II
 Physics 5600 – Statistical Mechanics

Below is a 4-year curriculum plan showing the proposed structure for the major.

Physics Major - New GE

| Year | Autumn Semester | Credit hours | Comment | Spring Semester | Credit Hours | Comment |
|------|-----------------------------------|--------------|------------------|-----------------------------------|--------------|--------------------|
| 1 | Physics 1270 ¹ | 5 | Intro Physics I | Physics 1271 ¹ | 5 | Intro Physics I |
| | Math 1151 | 5 | Calculus I | Math 1152 | 5 | Calculus II |
| | ASC 1100 | 1 | Survey | CSE 1222 ² | 3 | C++ Programming |
| | World Language 1 | 4 | | World Language 2 | 4 | |
| | | | | | | |
| | Total Hours | 15 | | Total Hours | 17 | |
| 2 | Physics 2300 | 4 | Mechanics I | Physics 2301 | 4 | Mechanics II |
| | Physics 2095 | 1 | Seminar | Physics 3700 | 3 | Data Ana. Lab |
| | Math 2153 | 4 | Calculus III | Math 2415 ⁴ | 3 | Diff. Equations |
| | World Language 3 | 4 | | Writing & Info Literacy | 3 | Gen Ed |
| | GenEd 1201 ³ | 1 | Launch Seminar | Literary, Visual, Performing Arts | 3 | Gen Ed |
| | Total Hours | 14 | | Total Hours | 16 | |
| 3 | Physics 5500 | 4 | Quantum | Physics 5400 | 4 | Electromagnetism |
| | Career Elective ⁸ | 3 | Min 12 hrs total | Physics Elective ⁷ | 4 | Required Elective |
| | Historical & Cultural Stds | 3 | Gen Ed | Physics 4700 ⁵ | 3 | Electronics Lab |
| | Thematic Pathways #1 | 3 | Gen Ed | Social & Behavioral Sciences | 3 | Gen Ed |
| | Free Elective ⁶ | 4 | | | | |
| | Total Hours | 17 | | Total Hours | 14 | |
| 4 | Career Elective ⁸ | 3 | Min 12 hrs total | Physics 5700 | 3 | Senior Lab |
| | Career Elective ⁸ | 3 | Min 12 hrs total | Career Elective ⁸ | 3 | Min 12 hrs total |
| | Race, Ethnicity, Gender Diversity | 3 | Gen Ed | Free Elective ⁶ | 3 | |
| | Thematic Pathways #2 | 3 | Gen Ed | Thematic Pathways #4 | 3 | Gen Ed |
| | Thematic Pathways #3 | 3 | Gen Ed | GenEd 4001 | 1 | Reflection Seminar |
| | Total Hours | 15 | | Total Hours | 13 | |

Courses in YELLOW are only offered in the term shown

¹ Students can take 1250-1251 or 1260-1261 (for students who started in Engineering Honors) in place of 1270-1271

² or CSE 1223 or CSE 1224 or Astronomy 1221

³ Students are required to complete the Launch Seminar within their first three semesters on campus

⁴ or 2174 or 2255 or 5520H. Linear Algebra (Math 2568) is recommended, but not required.

⁵ or Physics 5680 (Big Data Analytics) or Physics 5810 (Computational Physics)

⁶ Free electives are only required if a student needs to take extra courses in order to reach the minimum 121 credit hour requirement set by the College of Arts and Sciences.

⁷ Acceptable physics electives include Physics 5501, 5501H, 5401H, 3470, 5261, 5300, 5600, 5680 (if not taken as a lab), and 68xx

⁸ Talk to your physics academic advisor about career elective options

Timeline for Implementation

We propose for this change go in to effect starting autumn 2024 for all currently enrolled students and incoming students. Since we are not making changes to the core set of requirements to the major, no current students will be negatively affected by this change. After the proposal is approved by the university, we will communicate with students during the 2023-2024 academic year to prepare them for this curricular change.

Changes to Curriculum Map

The changes proposed only affect the elective portion of the major. Since the core set of physics course requirements will not change, there will also be no change to our curriculum map shown in appendix B.

Changes to Program Goals and Learning Outcomes

We are proposing one change to our Learning Outcomes which are:

1. Undergraduate Physics majors acquire a basic mastery of fundamental areas of physics, from classical mechanics, through electricity and magnetism, and finally to modern physics including quantum mechanics and relativity.
2. Undergraduate Physics majors develop powerful analytical and problem solving skills in areas involving both physics and mathematics.
3. Undergraduate Physics majors acquire a basic mastery of experimental physics.
4. Undergraduate Physics majors have acquired a basic mastery of data reduction and error analysis.
5. Undergraduate Physics majors effectively communicate their physical understanding both professionally and colloquially (orally and in writing).
6. Undergraduate majors are apprised of and encouraged to participate in academic research, industrial research and/or outreach activities which are consistent with their interest, ability and postgraduate plans.
7. Undergraduate majors acquire expertise relevant to their chosen program focus.

The proposed change is to remove outcome 7 because focuses will no longer be part of our curriculum. Note: since this learning outcome is difficult to assess, it is one that we have not included in our curriculum map or assessment plan. We had intended on removing this outcome prior to writing this proposal.

We are not requesting any changes to our Program Goals.

Changes to Assessment Plan

We are not requesting any changes to our current assessment plan other than we will not assess Learning Outcome number 7 as outlined above.

Appendix A – Current Curriculum Requirements

Core Requirements

- Minimum Required Physics: 33 semester hours
 - Physics 1270-1271 (or 1260-1261 or 1250-1251 or 1250H-1251H)
 - Physics 2095, 2300, 2301, 3700, 5400, 5500, 5700
- Minimum Required Math & Programming: 20-22 semester hours
 - Calculus - Math 1151, 1152, 2153 (or equivalent)
 - Differential Equations - Math 2415 (or 2174 or 2255 or 5520H)
 - Computer Programming - CSE 1222 (or CSE 1223 or CSE 1224 or Astronomy 1221)
- Required 3rd Lab (choose one):
 - Physics 4700: Electronics Lab Course (this is a controlled access course)
 - Physics 5680: Big Data Analytics in Physics
 - Physics 5810: Computational Physics
- Physics Elective (choose one): Physics 3470, 5261, 5300, 5401H, 5501, 5501H, 5600, or 5680 (if not taken as a 3rd lab)

Physics Focus Requirements

Advanced Physics Focus

The Advanced Physics Focus is designed for those intending graduate level work in physics or astronomy. It provides an excellent preparation for graduate school.

- Additional required physics courses (12 hours): Three additional physics electives beyond the one physics elective required by the core – for a total of four physics electives. It's recommended that three of the physics electives are 5501, 5600, and 5300. Students can choose what their fourth physics elective will be from the options listed in the core.
- Free electives (11 hours): these electives are only needed if the student has not reached the 121 credit hour minimum required by the College of Arts and Sciences to graduate.

Applied Physics Focus

The Applied Physics Focus is designed for students who plan to get a job after graduation or whose career plans lie outside of the other focuses. This focus has 15 hours of electives that students can target toward classes that will prepare them for their post-graduation plans.

- Technical Electives (15 hours): Students are required to choose 15 semester hours worth of electives that are 2000 level or above that are targeted toward their post-graduation plans. See a physics advisor for assistance in choosing appropriate electives. You are also welcome to browse the list of recommended electives.
- Free electives (8 hours): these electives are only needed if the student has not reached the 121 credit hour minimum required by the College of Arts and Sciences to graduate.

Life Sciences (Pre-Med) Focus

The Life Sciences Focus allows students to take the appropriate pre-requisite courses for Medical School alongside their major courses.

- Required GE courses (18 hours): Chemistry 1210, 1220; Biology 1113, 1114
- Required Pre-Med courses (12 hours): Chemistry 2510, 2520, 2540, 2550
- Free electives (11 hours): these electives are only needed if the student has not reached the 121 credit hour minimum required by the College of Arts and Sciences to graduate.

Physics Teaching Focus

The Physics Teaching Focus is designed for those seeking secondary level certification in physics (i.e., to be a high school teacher). It has been designed to satisfy the College of Education Master of Education (Physics Certification) curriculum. If you are interested in this option, contact the College of Education for further information.

- Required GE courses (13 hours): Chemistry 1210, 1220; Biology 1113
- Required pre-teaching courses (9 hours): Astronomy 2291, Geography 5900, Earth Sciences 1110
- Free electives (10 hours): these electives are only needed if the student has not reached the 121 credit hour minimum required by the College of Arts and Sciences to graduate.

4-year academic plans for each of the focuses (for both GEL and GEN) are available on the physics website: <https://physics.osu.edu/physics-programs-0/physics-major>

Appendix B – Physics Curriculum Map

No changes are being proposed. Note that, when compared to older curriculum maps, Physics 3201H has been removed due to it no longer being offered)

| | | Physics Major Program Outcomes | | | | | |
|-----------------------------|-------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| | | Undergraduate Physics majors acquire a basic mastery of fundamental areas of physics, from classical mechanics, through electromagnetism, and finally to modern physics including quantum mechanics and relativity. | Undergraduate Physics majors develop powerful analytical and problem solving skills in areas involving both physics and mathematics. | Undergraduate Physics majors acquire a basic mastery of experimental physics. | Undergraduate Physics majors acquire a basic mastery of data reduction and error analysis. | Undergraduate Physics majors effectively communicate their physical understanding both professionally and colloquially (orally and in writing). | Undergraduate Physics majors are apprised of and encouraged to participate in academic research, industrial research, and/or outreach activities which are consistent with their interest, ability, and post-graduation plans. |
| required courses | Physics 2095: Physics Seminar | | | | | | 3 |
| | Physics 2300: Mechanics I | 3 | 3 | 1 | | | |
| | Physics 2301: Mechanics II | 3 | 3 | 1 | | | |
| | Physics 3700: Data Analysis Lab | 1 | 3 | 3 | 3 | 3 | 1 |
| | Physics 5400: Electromagnetism | 3 | 3 | | | | |
| | Physics 5500: Quantum Mechanics | 3 | 3 | | | | |
| | Physics 5700: Physics Senior Lab | 2 | 3 | 3 | 3 | 3 | 2 |
| Required 3rd lab (choose 1) | Physics 4700: Electronics Lab | 2 | 3 | 3 | 2 | 3 | 2 |
| | Physics 5680: Big Data Analytics | 1 | 3 | 2 | 3 | 1 | 2 |
| | Physics 5810: Computational Physics | 1 | 3 | 2 | 2 | 2 | 2 |

Relationship: 1 light, 2 intermediate, 3 high