

## Physics Major Curriculum Change Request

Original submission: July 2023

Revised submission: September 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 transcripted.

### 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

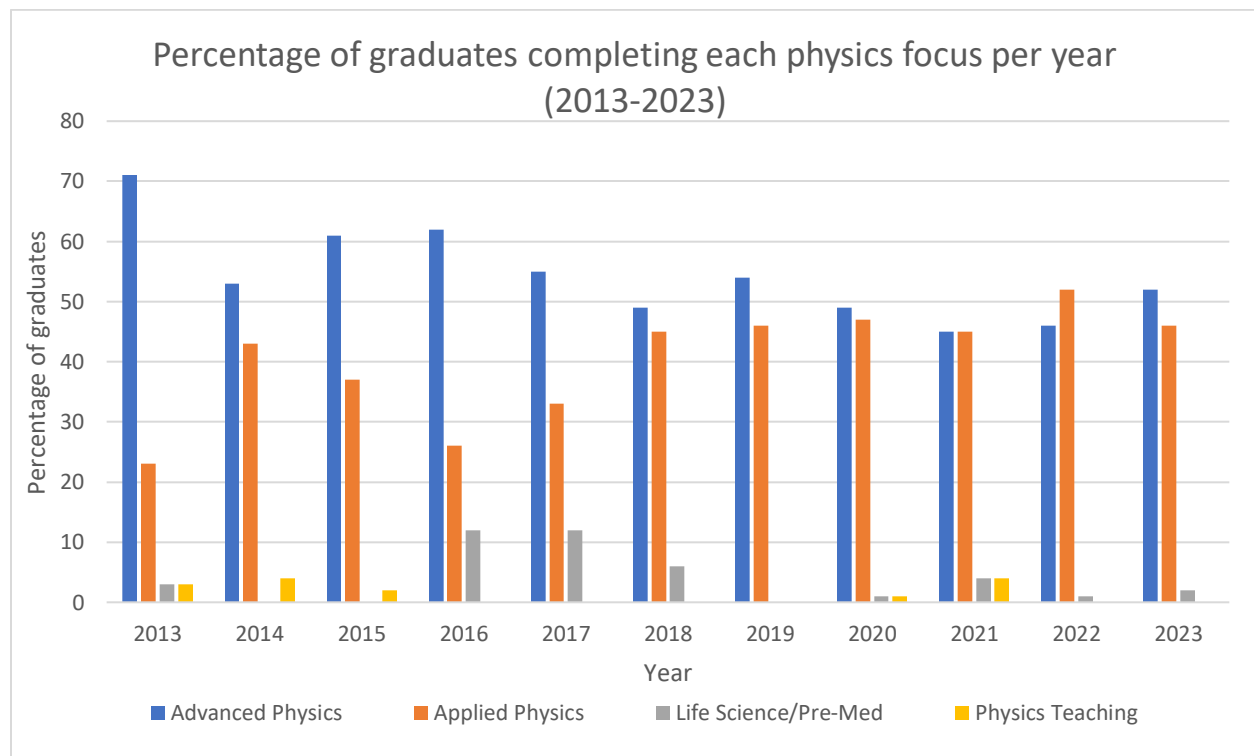
seminar course, students seem to need a one-on-one discussion about this before they feel like they have permission to have more flexibility with their curriculum.

### 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; Physics 4700, 5680, and 5810 can also be taken as a Physics Elective if not taken as a 3<sup>rd</sup> lab (a course cannot double count toward both a Physics Elective and a 3<sup>rd</sup> lab)
- 3<sup>rd</sup> 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 the below guidelines as to what can qualify as an elective. Those guidelines are:

- The course cannot already be required by the physics major program (e.g. a required prerequisite or part of the core)
- Students can apply up to two Theme GE courses to their major as Career Electives. The courses must be in different Themes (one in Citizenship and one in the “choice” Theme). No overlap is allowed between the Foundations GE categories and major coursework.
- The course must be graded A-E as opposed to pass/non-pass (with the exception of SP20 and AU20 courses) or satisfactory/unsatisfactory
- The course must be 2000 level or above
- Seminars and undergraduate research courses cannot count

Courses that meet the above criteria can count as a Career Elective. Students will work with a physics academic advisor to identify appropriate electives. An example list of possible electives include (^ indicates that the course is also approved as a GE Theme):

Astronomy 2140 – Planets and the Solar System^

Astronomy 2141 – Life in the Universe^

Chemistry 2510 & 2520 – Organic Chemistry I & II

Chemistry 2540 & 2550 – Organic Chemistry Laboratory I & II

Civil Engineering 3530 – Learning From Disasters: Extreme Events and Their Impact on Infrastructure, Engineering and Society^

Communication 2110 – Principles of Effective Public Speaking

Communication 2331 – Strategic Communication Principles^

Communication 2596^ – Communicating Science, Health, Environment, & Risk^

Communication 3240 – Science Communication

Communication 3404 – Media Law and Ethics

CSE 2221 – Software 1

Earth Sciences 2203 – Environmental Geoscience^

Earth Sciences 2911 – The Climate Crisis: Mechanisms, Impacts, and Mitigation^

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 3020 – Writing about Sustainability^

English 3022 – Media Sustainability^

English 3340 – Reimagining Climate Change^

English 3304 – Business and Professional Writing

English 3305 – Technical Writing  
English 3405 – Professional Communication  
Engineering 2300 – Exploring Diversity, Equity & Inclusion in Engineering Contexts^  
Geography 3755 – Geography of the European Union and the Challenges of Sustainability^  
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  
Public Affairs 2120 – Public Service and Civic Engagement^  
Public Affairs 2620 – Science, Engineering, and Technology Policy  
Public Affairs 3620 – US Space Policy and the Global Space Economy  
Public Affairs 5620 – Rapid Innovation for Public Impact

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 <sup>1</sup>	5	Intro Physics I	Physics 1271 <sup>1</sup>	5	Intro Physics I
	Math 1151	5	Calculus I	Math 1152	5	Calculus II
	ASC 1100	1	Survey	CSE 1222 <sup>2</sup>	3	C++ Programming
	World Language 1	4		World Language 2	4	
	<b>Total Hours</b>	<b>15</b>		<b>Total Hours</b>	<b>17</b>	
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 <sup>4</sup>	3	Diff. Equations
	World Language 3	4		Writing & Info Literacy	3	Gen Ed
	GenEd 1201 <sup>3</sup>	1	Launch Seminar	Literary, Visual, Performing Arts	3	Gen Ed
	<b>Total Hours</b>	<b>14</b>		<b>Total Hours</b>	<b>16</b>	
3	Physics 5500	4	Quantum	Physics 5400	4	Electromagnetism
	Career Elective <sup>8</sup>	3	Min 12 hrs total	Physics Elective <sup>7</sup>	4	Required Elective
	Historical & Cultural Stds	3	Gen Ed	Physics 4700 <sup>5</sup>	3	Electronics Lab
	Thematic Pathways #1	3	Gen Ed	Social & Behavioral Sciences	3	Gen Ed
	Free Elective <sup>6</sup>	4				
	<b>Total Hours</b>	<b>17</b>		<b>Total Hours</b>	<b>14</b>	
4	Career Elective <sup>8</sup>	3	Min 12 hrs total	Physics 5700	3	Senior Lab
	Career Elective <sup>8</sup>	3	Min 12 hrs total	Career Elective <sup>8</sup>	3	Min 12 hrs total
	Race, Ethnicity, Gender Diversity	3	Gen Ed	Free Elective <sup>6</sup>	3	
	Thematic Pathways #2	3	Gen Ed	Thematic Pathways #4	3	Gen Ed
	Thematic Pathways #3	3	Gen Ed	GenEd 4001	1	Reflection Seminar
	<b>Total Hours</b>	<b>15</b>		<b>Total Hours</b>	<b>13</b>	

Courses in YELLOW are only offered in the term shown

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

<sup>2</sup> or CSE 1223 or CSE 1224 or Astronomy 1221

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

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

<sup>5</sup> or Physics 5680 (Big Data Analytics) or Physics 5810 (Computational Physics)

<sup>6</sup> 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.

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

<sup>8</sup> Talk to your physics academic advisor about career elective options

## Timeline for Implementation

We propose for this change to go in to effect starting autumn 2024 for all incoming freshmen and transfer students who are new to OSU starting autumn 2024 and later. No current student will be impacted by this change.

## Embedded Literacies

Below are the embedded literacies for the Physics BS program.

Major Program	EL: Advanced Writing	EL: Data Analysis	EL: Technology
Physics (BS)	Physics 5700 “Advanced Physics Lab”	Physics 3700 “Experimental Physics Instrumentation and Data Analysis Lab”	Physics 5700 “Advanced Physics Lab”

## 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 3<sup>rd</sup> 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