The Department of Physics offers courses in astronomy, physics, and physical science that prepare students well for 21st century careers not always associated with physics in the past. The B.S. degree, with a major in physics, emphasizes the understanding of the theories of physics to solve fundamental and applied problems in science and technology using critical thinking, advanced computation, and systematic analysis. Physicists work effectively in many 21st century careers which require these skills, such as, basic, applied, and medical research; advanced materials and laser science; medical, financial, and legal services; product design and development; computer coding, advanced computational science, and software engineering; management, administration, and quality control; as well as in higher and secondary education.

The Department of Physics is a partner in the UABTeach initiative. UABTeach lets undergraduate students receive both their B.S. degree in physics and full teaching certification in four years. More information about the coordination between UABTeach and the UAB Physics Undergraduate program is available at the UABTeach Web site (http://www.uab.edu/uabteach/).

The department offers the following B.S. degrees and concentrations as well as a minor in physics:

1. **Major in Physics**
2. **Major in Physics – Advanced Physics Track**
3. **Major in Physics – Applied Physics Track**
4. **Major in Physics – Computational Physics Track**
5. **Major in Physics – Biophysics Track**

A Bachelor of Science degree with Honors in Physics is available for all tracks, and offers the motivated and capable physics major with the enhanced opportunity to develop the research, problem-solving and communication skills necessary to excel in a scientific career or in the marketplace.

Advising for all physics majors is provided by a professional advisor in conjunction with physics faculty members.

The Department of Physics Web site (http://www.uab.edu/physics/) summarizes information about the Departmental programs. Further information may be obtained from Dr. Renato Camata, Undergraduate Program Director at (205) 934-8143, camata@uab.edu.

### Accelerated Learning Opportunities

Students majoring in physics are eligible to apply to two Accelerated Bachelors/Masters (ABM) options:

1. **B.S. in Physics/M.S. in Data Science.** The Physics/Data Science ABM is an interdisciplinary program jointly offered by the Department of Physics and the Department of Computer Science. To accelerate progress through the B.S./M.S. degrees, pertinent computational M.S.-level PH/CS courses may substitute the chemistry content (8 credit hours) of the conventional undergraduate PH major. Similarly, the 3 credit hours of the conventional Physics Capstone course may be substituted by the CS/PH 698 research. Alternatively, up to 12 credit hours of M.S. courses may be counted as general electives towards the completion of the B.S. degree in physics and towards the completion of the M.S. degree in data science.

2. **B.S. in Physics/M.S. in Physics.** The Physics ABM is a research intensive program that allows students to combine undergraduate and graduate research while completing their Bachelor's Degree and working toward the Master's Degree. To accelerate progress through the B.S./M.S. degrees, up to 12 credit hours of M.S. courses may be counted as physics electives towards the completion of the B.S. degree and towards the completion of the M.S. degree.

Further information about these ABM opportunities may be obtained from Dr. Renato Camata, Undergraduate Program Director, camata@uab.edu or Dr. Shane Aaron Catledge, Graduate Program Director, catledge@uab.edu. Additional details and online application are available through the UAB Graduate School Web Page.

### Graduate Programs

The Department of Physics offers graduate study leading to the degrees of Master of Science and Doctor of Philosophy in physics. Further information may be obtained from Dr. Shane Aaron Catledge, Graduate Program Director at (205) 934-3693, catledge@uab.edu, or the UAB Graduate School Catalog.

See the UAB Graduate School Catalog for descriptions of graduate courses.

### Bachelor of Science with a Major in Physics

The curriculum of the Major in Physics provides fundamental knowledge in the core theories of physics.

<table>
<thead>
<tr>
<th>Requirements</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Required Mathematics Courses</strong></td>
<td></td>
</tr>
<tr>
<td>MA 125 Calculus I</td>
<td>4</td>
</tr>
<tr>
<td>or MA 225 Calculus I - Honors</td>
<td></td>
</tr>
<tr>
<td>MA 126 Calculus II</td>
<td>4</td>
</tr>
<tr>
<td>or MA 226 Calculus II - Honors</td>
<td></td>
</tr>
<tr>
<td>MA 227 Calculus III</td>
<td>4</td>
</tr>
<tr>
<td>MA 252 Introduction to Differential Equations</td>
<td>3</td>
</tr>
<tr>
<td><strong>Required Physics Courses</strong></td>
<td></td>
</tr>
<tr>
<td>PH 110 Topics in Contemporary Physics</td>
<td>1</td>
</tr>
<tr>
<td>PH 221 General Physics I</td>
<td>4</td>
</tr>
</tbody>
</table>
Additional Requirements

Physics or General Electives
Student must take physics or general electives to reach the 120 semester hour requirement.

Minor
A minor is required for this degree, unless a double major is being earned.

Bachelor of Science with a Major in Physics and an Advanced Physics Track

In addition to the requirements for the Major in Physics, students in the Advanced Physics Track are required to complete the following courses:

<table>
<thead>
<tr>
<th>Requirements</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>PH 446</td>
<td>Electromagnetic Theory II</td>
</tr>
<tr>
<td>PH 451</td>
<td>Introductory Quantum Mechanics II</td>
</tr>
</tbody>
</table>

Additional elective PH courses recommended for the Advanced Physics Track:

<table>
<thead>
<tr>
<th>Requirements</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>PH 310</td>
<td>Introduction to Quantum Computing</td>
</tr>
<tr>
<td>PH 418</td>
<td>Machine Learning Applications in Physics and Materials Science</td>
</tr>
<tr>
<td>PH 423</td>
<td>Computational Physics</td>
</tr>
<tr>
<td>PH 453</td>
<td>Introductory Solid State Physics I</td>
</tr>
<tr>
<td>PH 454</td>
<td>Introductory Solid State Physics II</td>
</tr>
<tr>
<td>PH 475</td>
<td>Introduction to Biophysics I</td>
</tr>
<tr>
<td>PH 491</td>
<td>Advanced Physics Laboratory I</td>
</tr>
<tr>
<td>PH 495</td>
<td>Honors Research</td>
</tr>
<tr>
<td>PH 497</td>
<td>Special Topics in Physics</td>
</tr>
</tbody>
</table>

The Advanced Physics Track is designed to prepare students for graduate studies in physics or other physical sciences. In addition to a strong foundation in the key theories of physics, this track encourages students to enroll in numerous advanced physics electives to broaden and deepen their preparation in physics.

Bachelor of Science with a Major in Physics and an Applied Physics Track

In addition to the requirements for the Major in Physics, students in this track are required to complete a minimum of nine semester hours of courses offered by Physics or other UAB departments that qualify as Applied Physics Track courses:

<table>
<thead>
<tr>
<th>Requirements</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Select a minimum of nine hours of courses that qualify as Applied Physics Track courses.</td>
<td>9</td>
</tr>
</tbody>
</table>
Bachelor of Science with a Major in Physics and a Computational Physics Track

In addition to the requirements of the Major in Physics, students in the Computational Physics Track are required to complete a minimum of nine semester hours of computationally intensive courses offered by Physics or other UAB departments.

Requirements

Select a minimum of nine hours of courses that qualify as Computational Physics Track courses:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>MA 360</td>
<td>Scientific Programming</td>
</tr>
<tr>
<td>MA 310</td>
<td>Introduction to Quantum Computing</td>
</tr>
<tr>
<td>MA 418</td>
<td>Machine Learning Applications in Physics</td>
</tr>
<tr>
<td>MA 423</td>
<td>Computational Physics</td>
</tr>
<tr>
<td>CS 203</td>
<td>Object-Oriented Programming in Java</td>
</tr>
<tr>
<td>CS 203L</td>
<td>Object-Oriented Programming Lab</td>
</tr>
<tr>
<td>CS 250</td>
<td>Discrete Structures</td>
</tr>
<tr>
<td>CS 303</td>
<td>Algorithms and Data Structures</td>
</tr>
<tr>
<td>CS 303L</td>
<td>Algorithms and Data Structures Laboratory</td>
</tr>
<tr>
<td>CS 416</td>
<td>Big Data Programming</td>
</tr>
<tr>
<td>CS 432</td>
<td>Parallel Computing</td>
</tr>
<tr>
<td>CS 460</td>
<td>Fundamentals of Artificial Intelligence</td>
</tr>
<tr>
<td>CS 470</td>
<td>Fundamentals of Computer Graphics</td>
</tr>
<tr>
<td>PH 110</td>
<td>Topics in Contemporary Physics</td>
</tr>
<tr>
<td>PH 201</td>
<td>College Physics I</td>
</tr>
<tr>
<td>PH 202</td>
<td>College Physics II</td>
</tr>
<tr>
<td>PH 223</td>
<td>General Physics III: Thermodynamics &amp; Quantum</td>
</tr>
<tr>
<td>PH 250</td>
<td>Computation, Theory, and Measurement in Quantum</td>
</tr>
<tr>
<td>PH 352</td>
<td>Statistical Thermodynamics I</td>
</tr>
<tr>
<td>PH 349</td>
<td>Physics Capstone</td>
</tr>
<tr>
<td>PH 359</td>
<td>Biomedical Optics</td>
</tr>
<tr>
<td>PH 423</td>
<td>Computational Physics</td>
</tr>
<tr>
<td>PH 420</td>
<td>Mathematical Methods of Physics I</td>
</tr>
<tr>
<td>PH 475</td>
<td>Introduction to Biophysics I</td>
</tr>
<tr>
<td>PH 478</td>
<td>Nanoscale Science and Applications</td>
</tr>
<tr>
<td>PH 481</td>
<td>Machine Learning Applications in Physics</td>
</tr>
<tr>
<td>PH 491</td>
<td>Advanced Physics Laboratory I</td>
</tr>
<tr>
<td>PH 492</td>
<td>Advanced Physics Laboratory II</td>
</tr>
</tbody>
</table>

Total Hours: 9

The Computational Physics Track is designed to provide graduates with valuable computational skills in the areas of simulation of physical processes, big data processing and experimental analysis, and high levels of mathematical reasoning.
... Click on the "Courses" tab at the top of this page for a full list of PH electives for the Biophysics Track.

Mathematics Elective
Select one of the following courses:

- MA 260 Introduction to Linear Algebra
- MA 265 Math Tools for Engineering Problem Solving
- MA 268 Introduction to Mathematical Biology
- MA 311 History of Mathematics I
- MA 312 History of Mathematics II
- MA 360 Scientific Programming
- MA 411 Integrating Mathematical Ideas
- MA 419 Special Topics
- MA 434 Algebra I: Linear
- MA 435 Algebra II: Modern
- MA 440 Advanced Calculus I
- MA 441 Advanced Calculus II
- MA 444 Vector Analysis
- MA 445 Complex Analysis
- MA 453 Transforms
- MA 454 Intermediate Differential Equations
- MA 455 Partial Differential Equations I
- MA 456 Partial Differential Equations II
- MA 461 Modeling with Partial Differential Equations
- MA 462 Intro to Stochastic Differential Equations
- MA 467 Gas Dynamics
- MA 468 Numerical Analysis
- MA 469 Numerical Analysis II
- MA 470 Differential Geometry
- MA 472 Geometry I
- MA 473 Geometry II
- MA 474 Introduction to Topology I
- MA 475 Introduction to Topology II
- MA 485 Probability
- MA 486 Mathematical Statistics

Total Hours 3

* PH 299 knowledge applied in PH 491 project

Additional Requirements

Students who have taken all or part of the PH 201-202 sequence before declaring a physics major may petition to have those courses substitute for PH 221-222.

Suggested plan for majoring in physics

The table below is meant to assist you in planning your path toward the B.S. degree in physics. Please consult with your Physics Faculty Track Mentor to select your Track Electives. Please consult with the Physics Academic Advisor to add the courses required by the UAB Core Curriculum. Additional requirements may apply depending on your affiliation with the Honors College, the Science and Technology Honors Program (STHP) or the University Honors Program (UHP).

Proposed Program of Study for a Major in Physics

- Consult with your Physics Faculty Track Mentor to select your Track Electives.
- Consult with the Physics Academic Advisor or an Honors College Advisor to add Core Curriculum courses or other requirements from Honors Programs.

Freshman

<table>
<thead>
<tr>
<th>Track Elective (e.g., CE 210, EE 314, MA 360, etc.)</th>
<th>Hours</th>
<th>Total Credit Hours 72</th>
</tr>
</thead>
</table>

Sophomore

<table>
<thead>
<tr>
<th>Track Elective (e.g., PH 310, PH 410, PH 487, etc.)</th>
<th>Hours</th>
<th>Total Credit Hours 72</th>
</tr>
</thead>
</table>

Junior

<table>
<thead>
<tr>
<th>Track Elective (e.g., PH 454, PH 482, PH 497, etc.)</th>
<th>Hours</th>
<th>Total Credit Hours 72</th>
</tr>
</thead>
</table>

Senior

<table>
<thead>
<tr>
<th>Track Elective (e.g., PH 454, PH 482, PH 497, etc.)</th>
<th>Hours</th>
<th>Total Credit Hours 72</th>
</tr>
</thead>
</table>

Total credit hours: 84-93

* Honors sections recommended for PH 221 and PH 222.

** Advanced Physics Track Requirement.

Minor in Physics

<table>
<thead>
<tr>
<th>Required Physic Courses</th>
<th>Hours</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Required Courses</th>
<th>Hours</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Physics Electives</th>
<th>Hours</th>
</tr>
</thead>
</table>

Select 6 hours from the following:

- PH 336 Physics of Current and Emerging Energy Technologies
- PH 350 Computation, Theory, and Measurement in Quantum Physics and Relativity
- PH 410 Physics of Fluids and Polymer Solutions

- * Honors sections recommended for PH 221 and PH 222.

** Advanced Physics Track Requirement.
PH 418 Machine Learning Applications in Physics and Materials Science
PH 420 Mathematical Methods of Physics I
PH 423 Computational Physics
PH 424 Biomedical Optics
PH 425 Applications of Contemporary Optics I
PH 432 Statistical Thermodynamics I
PH 445 Electromagnetic Theory I
PH 446 Electromagnetic Theory II
PH 450 Introductory Quantum Mechanics I
PH 451 Introductory Quantum Mechanics II
PH 453 Introductory Solid State Physics I
PH 454 Introductory Solid State Physics II
PH 461 Classical Mechanics I
PH 466 Applied Mechanics and Electromagnetism II
PH 475 Introduction to Biophysics I
PH 476 Introduction to Biophysics II
PH 481 Laser Physics I
PH 482 Laser Physics II
PH 487 Nanoscale Science and Applications

Total Hours 18

1 PH 221 General Physics I: Mechanics and PH 222 General Physics II: Electricity & Magnetism may also satisfy the Core Curriculum Area III: Natural Sciences requirement; check the Core Curriculum for your particular major.

GPA & Residency Requirement
A minimum grade of "C" is required in all courses applied to the minor, as well as all mathematics course prerequisites. A minimum of two physics courses must be completed at UAB.

Honors Program in Physics
The Physics Honors Program offers the motivated and capable physics major enhanced opportunities to develop the research, problem solving, and communication skills necessary for a dedicated effort in the scientific enterprise. By designing, describing, and defending a research project, the honors graduate will have a documented capacity for success in graduate school or in any career where scientific critical thinking, motivation, and accomplishment are valued.

Eligibility
Acceptance into the Physics Honors Program requires the student to:

• have earned a 3.25 GPA in physics courses attempted.
• have earned a 3.0 GPA overall.
• have completed 16 semester hours in physics, including PH 223 and PH 350.

Requirements
Students graduating with Physics Honors are required to have completed the following:

• completion of the proposed six semester hours of PH 495 Honors Research.
• maintenance of a 3.25 GPA in physics courses and an overall 3.0 GPA.
• a written report in the format required by an appropriate journal.
• an oral or poster presentation of the research project to the Honors Committee.

Benefits
The goal of the Physics Honors Program is to train capable undergraduates for uncommon accomplishment in academic research. The new physics honors graduate will have documented experience and productivity commonly found in second- or third-year graduate students. Ideally, the research project will result in publication and presentation at a national conference, giving the honors graduate strong credentials for graduate or medical/professional school, for industrial research, for science writing, and for teaching. Contacts made through publication and conferences and informed references written by mentor and committee members give the honors graduate a significant edge in the job market. The successful honors student will be recognized at the UAB Honors Convocation and will graduate “With Honors in Physics.”

Contact
Dr. Renato P. Camata
Director Undergraduate Physics Program
E-Mail: camata@uab.edu

Dr. Ilias Perakis, Chair
E-mail:iperakis@uab.edu
Telephone: (205) 934-4736
Mail address
UAB-Physics
1720 2nd Ave. S., CH310
Birmingham, AL 35294-1170 USA

AST-Astronomy Courses
AST 101. Astronomy of the Universe. 3 Hours.
Survey of the universe of matter and energy. Interpretation of observations to develop a self-consistent view of the universe, basic physical laws and structures, cosmic history and evolution. Quantitative Literacy is a significant component of this course. This course meets Blazer Core Scientific Inquiry with a Flag in High Impact Practices/Collaborative Assignments and Projects.

AST 102. Stars and Galaxies. 3 Hours.
Conceptual and collaborative approach to understanding the scientific processes by which astronomers make inferences about stars’ and galaxies’ formation and evolution from ground- and space-based observations. This course will include multicultural perspectives of the astronomical enterprise and sustainability of the nighttime environment. This course meets Blazer Core Scientific Inquiry with Flags in Sustainability and High Impact Practices/Collaborative Assignments and Projects.
AST 103. Astronomy of the Solar System. 3 Hours.
Descriptive and interpretive approach to solar and interplanetary phenomena, comets, and cometary/meteor relationships, asteroids and planetesimals, planetary surfaces, atmospheres, and interior structures. Physical law governing the solar system and quest for understanding its history and evolution, including formation. Lecture. This course meets Blazer Core Scientific Inquiry with a Flag in High Impact Practices/ Collaborative Assignments and Projects.

AST 105. Extraterrestrial Life. 3 Hours.
Interdisciplinary treatment (astronomy, chemistry, biology, planetary science, communications, and information sciences) of the universe as habitat, cosmic chemistry of molecules and evolution, environmental requirements, origin and occurrence of life, search for evidence, intelligence, communication, and contact. Lecture and laboratory. This course meets Blazer Core Scientific Inquiry with a Flag in High Impact Practices/Collaborative Assignments and Projects.

AST 111. Astronomy of the Universe Laboratory. 1 Hour.
Laboratory experience surveying the astronomical enterprise and the scientific study of the universe, including methods by which observations and measurements are interpreted to determine physical laws, cosmic history, and evolution. Multicultural perspectives toward the interpretation and protection of the night sky and astronomy. Specific experiences illuminate topics presented in AST 101. Must take with AST 101 to receive credit. This course meets Blazer Core Scientific Inquiry with Flags in High Impact Practices in Multicultural Perspectives, Sustainability, and Collaborative Assignments & Projects.

AST 112. Stars and Galaxies Laboratory. 1 Hour.
Laboratory experience in conceptual and collaborative approach to understanding the scientific processes by which astronomers make inferences about stars’ and galaxies’ formation and evolution from ground- and space-based observations. This course will include multicultural perspectives of the astronomical enterprise and sustainability of the nighttime environment. Specific experiences illuminate topics presented in AST 102. This course meets Blazer Core Scientific Inquiry with Flags in High Impact Practices in Multicultural Perspectives, Sustainability, and Collaborative Assignments & Projects.

AST 113. Astronomy of the Solar Systems Laboratory. 1 Hour.
Laboratory experience demonstrates how astronomy is practiced through observation experiences, laboratory experiments, and exercises involving analysis of data. Specific experiments illuminate topics presented in AST 103. Must take AST 103 to receive credit. This course meets Blazer Core Curriculum Scientific Inquiry with a flag in Collaborative Assignments and Projects.

AST 115. Extraterrestrial Life Laboratory. 1 Hour.
Laboratory experience illuminates topics presented in AST 105. Must take AST 105 to receive credit. This course meets Blazer Core Curriculum Scientific Inquiry with a flag in Collaborative Assignments and Projects.

AST 121. Protecting Starry Skies in Birmingham and Beyond. 3 Hours.
Examines perspectives and strategies for the protection of the natural nighttime environment. Beginning with multicultural perspectives of the night sky and darkness, students will explore scientific, social, and environmental issues related to the impact of artificial light at night on access to the night sky, public safety, and health. Skills to address these impacts will accrue through participation in a scientific service-learning project. Designed for students with little or no scientific experience. Meets Blazer Core Curriculum City as a Classroom with flags in Sustainability and Service/Community-Based Learning.

PH-Physics Courses

PH 100. Preparatory Physics. 3 Hours.
Designed primarily for students in need of preparation for PH 201 or PH 221. Vectors, kinematics, and dynamics, including conservation laws. Emphasis placed on methods of analyzing physics problems, setting up equations for physics problems, and interpreting information in physics problems.
Prerequisites: MA 106 [Min Grade: C] or MA 107 [Min Grade: C] or MA 125 [Min Grade: C] or MA 225 [Min Grade: C]

PH 103. Understanding the World Through Data. 3 Hours.
This course is designed to provide students of all disciplines with an introduction to using data and models to understand systems. This course features a carefully guided and curated selection of introductory-level topics related to modeling and simulation. Emphasis is placed on developing the inductive and deductive reasoning skills specific to the use of models in the physical sciences. Students will make and explore conjectures about data in a variety of disciplines, including physics, data science, biology, the social sciences, business, and finance. Students will be introduced to the use of simple models to visualize and qualitatively understand quantitative information via the Python programming language. No prior programming experience is necessary. This course meets Blazer Core Scientific Inquiry with a Flag in High Impact Practices/Collaborative Assignments.

PH 104. Community Data Research. 3 Hours.
Working with a team of other undergraduate students, students will engage in team-based/project-based learning opportunities to find answers to real-world data analysis questions relevant to Birmingham. This course is designed to provide students of all disciplines with a local experiential learning opportunity in data analysis and data communication by using the department of Physics expertise in Computational and Data-Driven Materials Physics Research. Students learn to solve problems by using data analysis and deliver data projects with relevance to our local community interests, local quality of life, and local economic development. This course features a carefully guided and curated selection of introductory-level topics related to data analytics and data modeling. Data analysis tools used within the context of the course are of relevance for the local and national STEM and data workforce. Emphasis is placed on developing inductive and deductive reasoning skills specific to the analysis of data and on using computational tools for model development and testing. Students will make and explore conjectures about data in a variety of disciplines, by using techniques developed in the fields of computational and data science and data-driven materials physics to understand social science, business, and finance. Students will be introduced to the use of simple models to visualize and qualitatively understand quantitative information. Students will work as part of a team to design and develop data analysis. This course meets Blazer Core City as a Classroom with flags in Civic Engagement & Collaborative Assignments and Projects.

PH 110. Topics in Contemporary Physics. 1 Hour.
The objective of this course is to introduce incoming freshmen to the different areas of physics and to topics that physicists are working on today. Through lectures and seminars by members of the UAB physics faculty, students are introduced to the UAB Department of Physics community, their research activities, and career opportunities for graduates in the various tracks of the Physics Undergraduate Program. Course required for physics majors in the first fall semester of residency.

PH 191. Co-operative Work Program. 2-3 Hours.
Co-Op Work Program.
PH 201. College Physics I. 4 Hours.
First term of non-calculus based physics. Linear and planar motion, Newton's laws, work and energy, gravitation, momentum, rigid body motion, elasticity, oscillations, waves, sound, fluids, ideal gases, heat and thermodynamics. Lecture and laboratory. Quantitative Literacy is a significant component of this course. This course meets Blazer Core Scientific Inquiry with a Flag in High Impact Practices/Collaborative Assignments and Projects.
Prerequisites: (MA 106 [Min Grade: C] or MA 106 [Min Grade: P]) or (MA 107 [Min Grade: C] or MA 107 [Min Grade: P]) or (MA 125 [Min Grade: C] or MA 125 [Min Grade: P]) or PH 100 [Min Grade: C] or MA 225 [Min Grade: C] or (MA 126 [Min Grade: C] or MA 126 [Min Grade: P]) or MA 226 [Min Grade: C] or (A02 25 and HSCG 3.5) or (A02 26 and HSCG 3.0) or A02 27 or (SAT2 580 and HSCG 3.5) or (SAT2 600 and HSCG 3.0) or SAT2 620 or MAC2 16 or MTH5 80 or (S02 600 and HSCG 3.5) or (S02 620 and HSCG 3.0) or S02 640 or MTH5 75 or MPL 76
PH 201L. College Physics Laboratory I. 0 Hours.
Laboratory for PH 201. Lecture, laboratory, and recitation must be taken concurrently.

PH 201R. College Physics I Recitation. 0 Hours.
First term of non-calculus based physics. Linear and planar motion, Newton's Law, work and energy, gravitation, momentum, rigid body motion, statics, elasticity, oscillations, waves, sound, fluids, ideal gases, heat, and thermodynamics. Lecture, laboratory, and recitation must be taken concurrently.

PH 202. College Physics II. 4 Hours.
Second term of non-calculus based physics. Electricity and magnetism, optics, and modern physics. Lecture, laboratory, and recitation must be taken concurrently. This course meets Blazer Core Scientific Inquiry with Flags in High Impact Practices/Collaborative Assignments and Projects and High Impact Practices/Undergraduate Research.
Prerequisites: PH 201 [Min Grade: C]

PH 202L. College Physics Laboratory II. 0 Hours.
Laboratory for PH 202. Lecture, laboratory, and recitation must be taken concurrently.

PH 202R. College Physics II - Recitation. 0 Hours.
Second term of non-calculus based physics sequence covering electricity and magnetism, optics, and modern physics. Lecture, laboratory, and recitation must be taken concurrently.

PH 211. College Physics I Laboratory. 0-1 Hours.
College Physics I Laboratory.

PH 212. College Physics II Lab. 1 Hour.

PH 221. General Physics I. 4 Hours.
First term of introductory, calculus-based general physics sequence covering classical mechanics: measurements, kinematics, vectors, translational and rotational dynamics, work, energy, momentum, statics, oscillatory motion, wave motion, and sound. Lecture and laboratory. Quantitative Literacy is a significant component of this course. This course meets Blazer Core Scientific Inquiry with a Flag in High Impact Practices/Collaborative Assignments and Projects.
Prerequisites: MA 125 [Min Grade: C] or MA 225 [Min Grade: C]

PH 221L. General Physics Laboratory I. 0 Hours.
Laboratory for PH 221. Lecture, laboratory, and recitation must be taken concurrently.

PH 221R. General Physics I Recitation. 0 Hours.
First term of introductory, calculus-based general physics sequence covering classical mechanics: measurements, kinematics, vectors, translational and rotational dynamics, work, energy, momentum, statics, oscillatory motion, wave motion, and sound. Lecture, laboratory, and recitation must be taken concurrently.

PH 222. General Physics II. 4 Hours.
Second term of introductory, calculus-based general physics sequence covering electricity and magnetism: Coulomb's Law, electric fields, Gauss' Law, potential, capacitors, and dielectrics, Ohm's Law, DC circuits, magnetic fields, Ampere's Law, Biot-Savart Law, Faraday's Law, inductance, AC circuits, geometrical and physical optics. Lecture, Laboratory, and Recitation must be taken concurrently. PH 222 General Physics II Honors: This section of PH 222 is designed for students with strong interests and preparation in science, mathematics, and/or engineering. Topics are covered with more mathematical rigor and in greater depth than in regular sections. This course meets Blazer Core Scientific Inquiry with Flags in High Impact Practices/Collaborative Assignments and Projects and High Impact Practices/Undergraduate Research.
Prerequisites: PH 221 [Min Grade: C] and (MA 126 [Min Grade: C] or MA 226 [Min Grade: C])

PH 222L. General Physics Laboratory II. 0 Hours.
Laboratory for PH 222. Lecture, Laboratory, and Recitation must be taken concurrently.

PH 222R. General Physics II - Recitation. 0 Hours.
Second term of introductory, calculus-based general physics sequence covering electricity and magnetism, Coulomb's Law, electric fields, Gauss' Law, potential, capacitors, and dielectrics, Ohm's Law, DC circuits, magnetic fields, Ampere's Law, Biot-Savart Law, Faraday's Law, inductance, AC circuits, geometrical and physical optics. Lecture, laboratory, and recitation must be taken concurrently.

PH 223. General Physics III: Thermodynamics & Quantum Physics. 4 Hours.
Study of topics in thermodynamics (including the kinetic theory of gases, as well as first and second laws of thermodynamics) and modern physics (including atomic structure, quantum mechanics, and applications to condensed matter, nuclear and particle physics). Specific applications in medical physics will also be discussed. Emphasis on the use of quantitative reasoning to solve thermodynamics and quantum physics problems. Writing and scientific ethics assignments based on laboratory experiences. Lecture and laboratory. Writing, Quantitative Literacy and Ethics and Civic Responsibility are significant components of this course.
Prerequisites: PH 222 [Min Grade: C]

PH 223L. General Physics Laboratory III. 0 Hours.
Laboratory for PH 223. Experimental work in the topics associated with PH 223, including atomic structure, quantum physics, and solid state physics. Successful students will develop their ability to collect and analyze experimental data, interpret the results, and present their findings in a clear, concise, and convincing way. Writing, Quantitative Literacy and Ethics and Civic Responsibility are significant components of this course.

PH 231. General Physics I Laboratory. 0-1 Hours.
General Physics I Laboratory.

PH 232. General Physics II Laboratory. 1 Hour.
General Physics II Laboratory.
PH 291. Physics Research Experiences. 3 Hours.
Physics Research Experiences (PH 291) is a 3 semester-hour course that provides students with the opportunity to participate in the design/discovery efforts of research teams under the supervision of an approved UAB faculty mentor, and to assist faculty and graduate students with research and development issues in their areas of expertise.

PH 299. Reasoning through Modeling and Simulation of Data. 3 Hours.
This course provides in-depth coverage of modeling and simulation topics with a focus on the use of acquired knowledge for project-based cooperative learning. Students will learn to reason in terms of models and will learn how well-validated models are used to understand data and make sense of complex systems in the physical sciences. Students will work with a team of peers and the course instructor to develop modeling and computational knowledge and skills, and apply them to the analysis of real-world data sets. Students will engage in modeling and simulation in areas including physics, data science, biology, the social sciences, and business and finance. This course introduces students to a variety of powerful modeling methods used in physics, which are ubiquitous across many fields of study. Students will be introduced to simulation via the Python programming language. No prior programming experience is necessary. This course meets Blazer Core Quantitative Literacy with Flags in High Impact Practices/Collaborative Assignments and Projects and High Impact Practices/Undergraduate Research.

PH 301. Instructional Astronomy I. 4 Hours.
Survey of selected topics in astronomy of the universe, stellar systems and solar systems with a focus on preparing to teach. Lecture and Laboratory must be taken concurrently.

PH 301L. Instructional Astronomy Laboratory. 0 Hours.
Laboratory for PH 301. Lecture and Laboratory must be taken concurrently.

PH 302. Instructional Physical Science. 4 Hours.
Lecture and discussion in areas of the physical sciences importance to basic scientific literacy and to current technology, with a focus on preparing to teach. Must be taken concurrently with PH 302L.

PH 302L. Instructional Physical Science Laboratory. 0 Hours.
Laboratory for PH 302.

PH 304. Intermediate Mechanics. 3 Hours.
Intermediate treatment of the kinematics and dynamics of classical systems. Presentation of problem solving techniques is emphasized.
Prerequisites: PH 222 [Min Grade: C]

PH 305. Intermediate Electricity and Magnetism. 3 Hours.
Intermediate treatment of electricity and magnetism including fields, potential, induction, Maxwell's equations, circuits. Presentation of problem solving techniques is emphasized.
Prerequisites: PH 222 [Min Grade: C]

An introduction to the principles and methods of physics related to engineering applications. Topics include thermodynamics, electricity and magnetism. Prerequisites: MA 226, MA 227, PH 221, PH 222, and permission of instructor. [Min Grade: C]

PH 309. Principles of Engineering Physics II. 3 Hours.
Continuation of PH 307. Advanced study of thermodynamics, electricity and magnetism. Applications in engineering and technology. Prerequisites: PH 307, MA 228, MA 229, and permission of instructor. [Min Grade: C]

PH 310. Introduction to Quantum Computing. 3 Hours.
This course introduces students to the world of quantum computation and quantum information. Students will engage in learning key algorithms and their implementations using quantum circuits. Students will develop an understanding of the major differences between traditional (classical) and modern quantum computing. Through coding and quantum simulations using Python programming language, students will develop an understanding of quantum computing models and basic algorithms — e.g., Deutch-Jozsa, Simon, Quantum Fourier transform, Shor, and Grover's search algorithm. No prior programming experience is necessary. By discussing interdisciplinary topics in materials and device physics, students will also develop an appreciation for the quantum hardware necessary to run these algorithms.
Prerequisites: PH 221 [Min Grade: C]

PH 331. Classical Thermodynamics. 3 Hours.
Introduction to thermal phenomena on a macroscopic and statistical basic, principles and laws governing them.
Prerequisites: PH 222 [Min Grade: C] and MA 227 [Min Grade: C]

PH 336. Physics of Current and Emerging Energy Technologies. 3 Hours.
The technologies involved in energy conversion, storage, and transmission, represent one of the cornerstones of modern civilization. In this course, the principles of mechanics, electromagnetism, thermodynamics, and quantum physics are applied to the understanding of current and emerging energy technologies. Topics include electrical power generation from conventional and renewable resources, electrochemical and thermal energy storage, as well as power transmission via electrical, optical, and superconducting systems.
Prerequisites: PH 222 [Min Grade: C]

An emphasis on the principles of experimental physics at an advanced level, including computational modeling/analysis via introduction to Python coding. Lectures focused on the theoretical basis of modern physics topics with applications in special relativity, quantum mechanics, atomic and nuclear structure, solid-state physics, semiconductors, lasers and nanotechnology.
Prerequisites: PH 223 [Min Grade: C] or PH 351 [Min Grade: C]

PH 350L. Computation, Theory, and Measurement in Quantum Physics and Relativity Laboratory. 0 Hours.
Laboratory for PH 350. Experimental work in the topics associated with PH 350 at a level of investigation to more strongly develop the connections between theory and experiment. Experiments are designed to verify fundamental concepts in modern physics and will integrate computer codes to analyze and visualize the data collected in the laboratory. Students will organize and maintain a rigorous laboratory notebook and will prepare/present scientific reports for these experiments as a major component of the course. Successful students will refine their data collection, analysis, and interpretation and scientific presentation skills. Writing, Quantitative Literacy and Ethics and Civic Responsibility are significant components of this course.

PH 397. Directed Reading in Physics I. 2-3 Hours.
Tutorial studies in physics offered by special arrangement. Permission of instructor.

PH 398. Directed Reading in Physics II. 2-3 Hours.
Tutorial studies in physics offered by special arrangement. Permission of instructor.
PH 410. Physics of Fluids and Polymer Solutions. 3 Hours.
This course provides an introduction to fluid mechanics and polymer physics appropriate for physics, engineering, chemistry, and biology majors. Topics include the concept of a fluid, the fluid as a continuum, properties of the velocity field, thermodynamic properties of a fluid, viscosity, pressure distribution in a fluid, basic physical laws of fluid mechanics, the Reynolds transport theorem, differential relations for a fluid particle, viscous flow, polymer solutions and thermodynamics, Brownian motion, diffusion equation, Fick's law, Stokes-Einstein equation and hydrodynamic radius of a polymer chain, and viscosity of polymer solutions.
Prerequisites: PH 221 [Min Grade: C] and MA 252 [Min Grade: C]

PH 418. Machine Learning Applications in Physics and Materials Science. 3 Hours.
This course covers interdisciplinary topics in data science, computer science, and materials physics, with a focus on introducing first-principles software based on density-functional theory and data-driven machine-learning discoveries for applications in materials science and other physics domains.
Prerequisites: PH 350 [Min Grade: C]

PH 420. Mathematical Methods of Physics I. 3 Hours.
Prerequisites: PH 222 [Min Grade: C] and MA 252 [Min Grade: C] or EGR 265 [Min Grade: C]

PH 421. Mathematical Methods of Physics II. 3 Hours.
Prerequisites: PH 420 [Min Grade: C]

PH 423. Computational Physics. 3 Hours.
Introduces symbolic and numerical computation through examples drawn from classical and modern physics, such as, classical mechanics, electromagnetism, and quantum mechanics. Emphasizes computer-based approaches to visualization, solution of ordinary differential equations, evaluation of integrals, and finding roots, eigenvalues, and eigenvectors.
Prerequisites: MA 252 [Min Grade: C] or EGR 265 [Min Grade: C] and PH 222 [Min Grade: C]

PH 424. Biomedical Optics. 3 Hours.
The objective in this class is to present an introduction to applied optics, with an emphasis on biomedical applications.
Prerequisites: PH 222 [Min Grade: C]

PH 425. Applications of Contemporary Optics I. 3 Hours.
Prerequisites: PH 222 [Min Grade: C]

PH 426. Applications of Contemporary Optics II. 3 Hours.
Prerequisites: PH 425 [Min Grade: C]

PH 427. Geometrical Optics. 4 Hours.
Prerequisites: PH 222 [Min Grade: C]

PH 427L. Geometrical Optics Laboratory. 0 Hours.
Laboratory for PH 427. Lecture and laboratory must be taken concurrently.

PH 428. Physical Optics. 4 Hours.
Prerequisites: PH 222 [Min Grade: C]

PH 428L. Physical Optics Laboratory. 0 Hours.
Laboratory for PH 428. Lecture and laboratory must be taken concurrently.

PH 429. Applications of Contemporary Optics III. 3 Hours.
Optical interactions with materials, including nonlinear optical effects, such as birefringence, electro-optics, photoelasticity, crystal optics, acousto-optics, and phase conjugation. Optical spectroscopies, such as spectroscopic instrumentation, lasers as spectroscopic light sources, fluorescence and Raman laser spectroscopy, and applications of laser spectroscopy in chemistry, environmental research, materials science, biology, and medicine.
Prerequisites: PH 425 [Min Grade: C] and PH 426 [Min Grade: C]

PH 432. Statistical Thermodynamics I. 3 Hours.
Statistical basis of laws of thermodynamics. Ensembles and partition functions. Quantum statistics of ideal gases, including photons and electrons. Applications to solids, real gases, liquids, and magnetic systems. Transport theory.
Prerequisites: PH 223 [Min Grade: C]

PH 433. Statistical Thermodynamics II. 3 Hours.
Statistical basis of laws of thermodynamics. Ensembles and partition functions. Quantum statistics of ideal gases, including photons and electrons. Applications to solids, real gases, liquids, and magnetic systems. Transport theory.
Prerequisites: PH 432 [Min Grade: C] and PH 450 [Min Grade: C]

PH 435. Physics of Biomedical Processes and Technologies. 3 Hours.
Integrated study of the fundamentals and dynamical principles of mechanics, electromagnetism, and select quantum physics topics, with applications to biomechanical systems, biophysical networks, and bioimaging technologies.
Prerequisites: PH 461 [Min Grade: C] and PH 445 [Min Grade: C]

PH 436. Physics of Renewable Energy Systems. 3 Hours.
Integrated study of the fundamentals and dynamical principles of mechanics, electromagnetism, and select quantum physics topics, with applications to electrical power generation from renewable resources such as solar, wind, hydro, and ocean energy.
Prerequisites: PH 461 [Min Grade: C] and PH 445 [Min Grade: C]

PH 445. Electromagnetic Theory I. 3 Hours.
Electromagnetic theory approached from the standpoint of fields and using Maxwell's equations.
Prerequisites: PH 222 [Min Grade: C] and PH 420 [Min Grade: C]

PH 446. Electromagnetic Theory II. 3 Hours.
Electromagnetic theory approached from the standpoint of fields and using Maxwell's equations.
Prerequisites: PH 445 [Min Grade: C]
PH 447. Directed Reading in Electromagnetic Theory. 2-3 Hours.
Tutorial studies in electromagnetic theory offered by special arrangement.

PH 450. Introductory Quantum Mechanics I. 3 Hours.
Principles of quantum mechanics and their application to particle waves, angular momentum, tunneling, radiation, and selection rules. Perturbation and variational methods. Successful completion of PH 350 is recommended prior to registering for this class.
Prerequisites: PH 350 [Min Grade: C] and PH 461 [Min Grade: C]

PH 451. Introductory Quantum Mechanics II. 3 Hours.
Principles of quantum mechanics and their application to particle waves, angular momentum, tunneling, radiation, and selection rules. Perturbation and variational methods. Successful completion of PH 350 is recommended prior to registering for this class.
Prerequisites: PH 450 [Min Grade: C]

PH 452. Directed Reading in Quantum Mechanics. 2-3 Hours.
Tutorial studies in quantum mechanics offered by special arrangement.

PH 453. Introductory Solid State Physics I. 3 Hours.
Properties of crystal lattices, lattice dynamics, lattice imperfections, and bonding energies. Electronic properties of dielectrics, semiconductors, and metals. Ferroelectric, magnetic, and optical properties of solids.
Prerequisites: PH 450 [Min Grade: C] (Can be taken Concurrently)

PH 454. Introductory Solid State Physics II. 3 Hours.
Properties of crystal lattices, lattice dynamics, lattice imperfections, and binding energies. Electronic properties of dielectrics, semiconductors, and metals.
Prerequisites: PH 453 [Min Grade: C]

PH 455. Molecular Spectroscopy. 3 Hours.
Molecular Spectroscopy.

PH 461. Classical Mechanics I. 3 Hours.
Kinematics and dynamics, including central forces, rotating coordinate systems, and generalized coordinates. Lagrangian, Hamiltonian, and other equivalent formulations of mechanics.
Prerequisites: PH 222 [Min Grade: C] and (MA 252 [Min Grade: C] or EGR 265 [Min Grade: C])

PH 462. Classical Mechanics II. 3 Hours.
Kinematics and dynamics, including central forces, rotating coordinate systems, and generalized coordinates. Lagrangian, Hamiltonian, and other equivalent formulations of mechanics.
Prerequisites: PH 461 [Min Grade: C]

PH 463. Directed Reading in Classical Mechanics. 2-3 Hours.
Tutorial studies in classical mechanics offered by special arrangement.

PH 467. Special Relativity. 3 Hours.
Principles and foundations of special relativity with applications to mechanics and electrodynamics.
Prerequisites: PH 446 [Min Grade: C] and PH 462 [Min Grade: C]

PH 468. General Relativity. 3 Hours.
Gravitational phenomena associated with and resulting from linear field equations. Equivalence principle, its implications of non-linear field, and physical consequences.

PH 469. Directed Reading in Physics. 2-3 Hours.
Tutorial studies in physics offered by special arrangement.

PH 471. Fundamentals of Spectroscopy. 3 Hours.
Explanation of phenomena related to rotational vibration and electronic spectroscopy of atoms and molecules; operational principles of spectroscopic tools including diffraction grating, waveguides and interferometers, basic group theory concepts and notation.

PH 475. Introduction to Biophysics I. 3 Hours.
Physics of biological systems: proteins, lipids, nucleic acids, supramolecular structures, and molecular motors; structure, function, energetics, thermodynamics, and bio-nanotechnology. Emphasis on systems that are best understood in physical and molecular detail. Systems will direct study, with modern physical methods introduced as needed.
Prerequisites: PH 223 [Min Grade: C]

PH 476. Introduction to Biophysics II. 3 Hours.
Physics of biological systems: proteins, lipids, nucleic acids, supramolecular structures, and molecular motors; structure, function, energetics, thermodynamics, and bio-nanotechnology. Emphasis on systems that are best understood in physical and molecular detail. Systems will direct study, with modern physical methods introduced as needed.
Prerequisites: PH 475 [Min Grade: C]

PH 481. Laser Physics I. 3 Hours.
Physical principles of laser operation and design. Spontaneous and stimulated emission, population inversion, light amplification, laser resonators, Q-switching, mode-locking, pulse shortening techniques, spectral narrowing, and tunable lasers. Individual types of lasers such as gas, solid state, dye, color center, and semiconductor. Practical applications of lasers as well as modern techniques and instrumentation in laser spectroscopy.
Prerequisites: PH 482 [Min Grade: C]

PH 482. Laser Physics II. 3 Hours.
Physical principles of laser operation and design. Spontaneous and stimulated emission, population inversion, light amplification, laser resonators, Q-switching, mode-locking, pulse shortening techniques, spectral narrowing, and tunable lasers. Individual types of lasers such as gas, solid state, dye, color center, and semiconductor. Practical applications of lasers as well as modern techniques and instrumentation in laser spectroscopy.
Prerequisites: PH 481 [Min Grade: C]

PH 485. Laser Spectroscopy. 3 Hours.
Fundamental principles, experimental techniques, instrumentation, and practical applications of laser spectroscopy.

PH 486. Semiconductor Materials in Modern Technology. 3 Hours.
Brief review of electronic materials with emphasis on traditional and cutting edge silicon technology. Competing and complementary semiconductors covered in standard lecture and seminar style. Materials: compound and tertiary semiconductors, organic semiconductors, and wide bandgap semiconductors. Applications: optical and chemical sensors, microwave electronics, high power electronics, and lasers. Specific applications and materials determined by student interests.
Prerequisites: PH 350 [Min Grade: C] or EE 351 [Min Grade: C] or CH 326 [Min Grade: C]

PH 487. Nanoscale Science and Applications. 3 Hours.
Physics of electronic, mechanical, and biological properties of materials at the nanoscale level approaching one billionth of a meter. The applications of nanoscale materials in electronic, mechanical, and biomedical systems will be emphasized. Special tools in synthesis and characterization of nanomaterials will be discussed.
Prerequisites: (PH 221 [Min Grade: C] and PH 222 [Min Grade: C]) or (CH 115 [Min Grade: C] and CH 117 [Min Grade: C])
**PH 490. Preparations for Teaching. 1-4 Hour.**
This class prepares physics majors for successful teaching experiences. The course emphasizes a foundation of practical knowledge related to expectations and duties shared by teachers in physics education, as well as an opportunity to read, reflect, and discuss current research related to physics teaching and learning in secondary and higher education.

**Prerequisites:** PH 350 [Min Grade: C]

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**PH 491. Advanced Physics Laboratory I. 1-4 Hour.**
This course provides physics majors with the opportunity to integrate the physics knowledge acquired in earlier courses in a research environment under the supervision of an approved UAB faculty mentor.

**Prerequisites:** PH 350 [Min Grade: C]

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**PH 492. Advanced Physics Laboratory II. 1-4 Hour.**
This course provides physics majors with the opportunity to integrate the physics knowledge acquired in earlier courses in a research environment under the supervision of an approved UAB faculty mentor.

**Prerequisites:** PH 491 [Min Grade: C]

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**PH 493. Advanced Physics Laboratory III. 1-4 Hour.**
This course provides physics majors with the opportunity to integrate the physics knowledge acquired in earlier courses in a research environment under the supervision of an approved UAB faculty mentor.

**Prerequisites:** PH 492 [Min Grade: C]

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**PH 494. Research Methods in Physics. 1-3 Hour.**
This course is designed to provide future physics teachers with the tools that physicists use to solve scientific problems; to give them the opportunity to use these tools in a physics laboratory setting; to make them aware of how scientists communicate with each other through peer-reviewed scientific literature; and to enable them to understand how scientists in general and physicists in particular develop new knowledge and insights, the most important of which are eventually presented in textbooks and taught in conventional science classes.

**Prerequisites:** EHS 126 [Min Grade: C]

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**PH 495. Honors Research. 1-3 Hour.**
Research under the direction of a faculty sponsor and the Honors Committee. Admission to Departmental Honors in Physics required. May be repeated.

**Prerequisites:** PH 350 [Min Grade: C]

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**PH 497. Special Topics in Physics. 1-6 Hour.**
Topics of current interest, such as theoretical physics, computational physics, experimental techniques. May be repeated for credit.

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**PH 498. Directed Research. 1-6 Hour.**
Directed Research.

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**PH 499. Physics Capstone. 3 Hours.**
Instructional sessions, conclusion of research or teaching project and career planning activities aimed at the integration of physics knowledge and competencies in scientific writing, quantitative literacy, and ethics and civic responsibility.

**Prerequisites:** PH 490 [Min Grade: C] or PH 491 [Min Grade: C] or PH 495 [Min Grade: C]