Department of Physics

Chair: Dr. Ilias Perakis

The Department of Physics provides the Foundations for Tomorrow's Innovators: A Liberal Arts Approach to Science in the Age of AI and Beyond

In our department, we view Physics not only as a cornerstone of scientific exploration but also as a pathway to cultivating the critical thinking, adaptability, and ethical decision-making necessary for success in the Fourth Industrial Revolution, where Artificial Intelligence (AI) and Automation are reshaping every facet of life. Physics, much like the liberal arts, is now "robot-proofing" our students by equipping them with a broad set of tools and human skills for understanding complex systems—whether they be physical, technological, or societal.

1. Cultivating Intellectual Curiosity and Interdisciplinary Thinking

Our curriculum goes beyond conventional boundaries, encouraging students to integrate knowledge across physics, engineering, data science, and the humanities. This approach builds a mindset of inquiry, where students learn to approach scientific questions from multiple perspectives, a skill essential for tackling the challenges of an interconnected, AI-driven world.

2. Preparing for Technological and Societal Impact

In today's world, advances in AI, quantum computing, and sustainability call for scientists who not only understand these technologies but can foresee their societal impacts. By fostering a "scientist-citizen" philosophy, we prepare students to address ethical and societal questions alongside technical problems. This balanced approach builds leaders who can anticipate the broader implications of their work, contributing responsibly and innovatively to society.

3. Integrating Research and Real-World Application

Our department emphasizes hands-on, collaborative research that connects students with both real-world applications and scientific breakthroughs. Through partnerships with industry, research, and community initiatives, students gain experience that translates theoretical learning into practical impact. Programs like our Magic City Data Collective data science internships and work-based learning initiatives in our new Science & Engineering building provide invaluable experience, positioning our graduates as versatile and potentially sought-after professionals.

4. A Supportive Environment for Developing a "Physics Identity"

We recognize the importance of belonging and identity in academic success. Our holistic support system—combining mentorship, peer collaboration, and financial support—ensures that all students, independent of their background, can thrive and see themselves as integral members of our big community. We foster a culture that celebrates different perspectives, which is essential for building resilience and innovation in future scientific leaders.

5. Physics as Preparation for Lifelong Learning and Leadership

The skills developed through a liberal arts-inspired approach to Physics—critical thinking, adaptability, hands-on experience in the laboratory and the computer, and a continuous drive for knowledge—prepare students for dynamic career paths. Whether advancing to graduate studies, joining the tech sector, or impacting public policy, our graduates are equipped to lead and to learn in a world where change is constant.

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/).

A Bachelor of Science degree with Honors in Physics is available for all concentrations, 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.

Undergraduate Certificate in Data-Driven Modeling

The department also offers a Certificate in Data-Driven Modeling *open to all majors.* Data-intensive fields are growing, and future employees in STEM careers need to be able to understand and contribute to complex data projects. This certificate is designed to enhance the training and education provided to all majors and emphasizes key critical skills across five required courses that grow in complexity as students advance. Students learn data processing concepts, Python programming, supervised machine learning models, and unsupervised learning such as principal component analysis and clustering techniques. The certificate also introduces deep learning and neural networks.

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 MS 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.

Requirements		Hours
Blazer Core Curriculum		**41**
General Electives		**18**
Required Mathematics Courses		
MA 125	Calculus I	4
or MA 225	Calculus I - Honors	
MA 126	Calculus II	4
or MA 226	Calculus II - Honors	
MA 227	Calculus III	4
MA 252	Introduction to Differential Equations	3
Required Physics Courses		
PH 110	Topics in Contemporary Physics	1
PH 221	General Physics I	4
PH 222	General Physics II	4
PH 223	General Physics III: Thermodynamics & Quantum Physics	4
PH 350	Computation, Theory, and Measurement in Quantum Physics and Relativity	4
PH 420	Mathematical Methods of Physics I	3
PH 432	Statistical Thermodynamics I	3
PH 445	Electromagnetic Theory I	3
PH 450	Introductory Quantum Mechanics I	3
PH 461	Classical Mechanics I	3
PH 499	Physics Capstone	3
Required Chemistry Courses		
CH 115 & CH 116	General Chemistry I and General Chemistry I Laboratory	4
CH 117 & CH 118	General Chemistry II and General Chemistry II Laboratory	4
Mathematics Elective		
Select one of the following courses:		3-4
MA 260	Introduction to Linear Algebra	
MA 265	Math Tools for Engineering Problem Solving	
MA 268	Mathematics of Biological Systems II	
MA 311	History of Mathematics I	
MA 312	History of Mathematics II	
MA 360	Scientific Programming	
MA 361	Mathematical Modeling	
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	Fourier Analysis	
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 I	
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 I	
Total Hours		**120-121**

Grade Requirement

Students must earn a grade of “C” or better in all courses applied to this major.

Additional Requirements

Physics or General Electives

Students 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:

Requirements		Hours
PH 446	Electromagnetic Theory II	3
PH 451	Introductory Quantum Mechanics II	3
Additional elective PH courses recommended for the Advanced Physics Track:		
PH 310	Introduction to Quantum Computing	
PH 418	Machine Learning Applications in Physics and Materials Science	
PH 423	Computational Physics	
PH 453	Introductory Solid State Physics I	
PH 454	Introductory Solid State Physics II	
PH 475	Introduction to Biophysics I	

PH 491	Advanced Physics Laboratory I	
PH 495	Honors Research	
PH 497	Special Topics in Physics	
Total Hours		**6**

Note: *Review the "*Courses*" tab at the top of this page or visit the* Department of Physics *website for a full list of PH electives for the Advanced Physics Track.*

The Advanced Physics Track is designed to prepare students for graduate studies in physics or other physical sciences. In additional 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:

Requirements		Hours
Select a minimum of nine hours of courses that qualify as Applied Physics Track courses.		9
For example:		
PH 310	Introduction to Quantum Computing	
PH 418	Machine Learning Applications in Physics and Materials Science	
PH 437	Digitally-Assisted Additive Manufacturing Technologies	
PH 438	Data-driven Discovery, Synthesis, and Analysis	
PH 453	Introductory Solid State Physics I	
PH 481	Laser Physics I	
PH 487	Nanoscale Science and Applications	
PH 497	Special Topics in Physics	
Total Hours		**9**

Note: *Please visit the* Department of Physics *website for a full list of courses offered by Physics and other UAB departments that qualify as Applied Physics Track courses.*

The Applied Physics Track is designed to prepare students for careers in industry or other technology enterprises. A judicious choice of courses that qualify as Applied Physics Track courses allows graduates to develop a competitive set of professional skills.

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		Hours
Select a minimum of nine hours of courses that qualify as Computational Physics Track courses:		9
For example:		
MA 360	Scientific Programming	
PH 310	Introduction to Quantum Computing	
PH 418	Machine Learning Applications in Physics and Materials Science	
PH 423	Computational Physics	
CS 203	Object-Oriented Programming in Java	
CS 203L	Object-Oriented Programming Lab	
CS 250	Discrete Structures	
CS 303	Algorithms and Data Structures	
CS 303L	Algorithms and Data Structures Laboratory	
CS 416	Big Data Programming	
CS 432	Parallel Computing	
CS 460	Fundamentals of Artificial Intelligence	
CS 470	Fundamentals of Computer Graphics	
Total Hours		**9**

Note: *Please visit the* Department of Physics *website for a full list of courses offered by Physics and other UAB departments that qualify as Computational Physics Track courses.*

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.

Bachelor of Science with a Major in Physics and a Biophysics Track

The Biophysics Track is a multidisciplinary program of study that equips students for the quantitative knowledge demands of modern biomedical fields, including placement in medical school, health professions, graduate school in the biosciences, and biotech enterprises. A balanced, flexible mix of physics, chemistry, biology and math is required.

Requirements		Hours
Required Biology		
BY 123	Introductory Biology I	4
BY 124	Introductory Biology II	4
Required Chemistry		
CH 115 & CH 116	General Chemistry I and General Chemistry I Laboratory	4
CH 117 & CH 118	General Chemistry II and General Chemistry II Laboratory	4
CH 235 & CH 236	Organic Chemistry I and Organic Chemistry I Laboratory	4
CH 237 & CH 238	Organic Chemistry II and Organic Chemistry II Laboratory	4
Required Mathematics		
MA 125	Calculus I	4
or MA 225	Calculus I - Honors	
MA 126	Calculus II	4
or MA 226	Calculus II - Honors	
PH 299 & PH 491	Reasoning through Modeling and Simulation of Data and Advanced Physics Laboratory I *	4
or MA 227	Calculus III	
MA 252	Introduction to Differential Equations	3
Required Physics Courses		
PH 110	Topics in Contemporary Physics	1
PH 201	College Physics I	4

or PH 221	General Physics I	
PH 202	College Physics II	4
or PH 222	General Physics II	
PH 223	General Physics III: Thermodynamics & Quantum Physics	4
PH 350	Computation, Theory, and Measurement in Quantum Physics and Relativity	4
PH 432	Statistical Thermodynamics I	3
PH 499	Physics Capstone	3
Physics Electives		
Select seven hours of Physics (PH) courses at the 400 level. #		7
For example:		
PH 475	Introduction to Biophysics I	
PH 487	Nanoscale Science and Applications	
PH 410	Physics of Fluids and Polymer Solutions	
PH 418	Machine Learning Applications in Physics and Materials Science	
PH 424	Biomedical Optics	
PH 423	Computational Physics	
PH 420	Mathematical Methods of Physics I	
PH 336	Physics of Current and Emerging Energy Technologies	
PH 491	Advanced Physics Laboratory I	
Mathematics Elective		
Select one of the following courses:		3
MA 260	Introduction to Linear Algebra	
MA 265	Math Tools for Engineering Problem Solving	
MA 268	Mathematics of Biological Systems II	
MA 311	History of Mathematics I	
MA 312	History of Mathematics II	
MA 360	Scientific Programming	
MA 361	Mathematical Modeling	
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	Fourier Analysis	
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 I	
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 I	
Total Hours		**72**

* PH 299 knowledge applied in PH 491 project

\# Review the "*Courses*" tab at the top of this page for a full list of PH electives for the Biophysics Track.

Bachelor of Science in Physics with a Concentration in Data-Driven Modeling and Technology

The Data-Driven Modeling and Technology concentration is a flexible program aligned with the rapidly evolving graduate and data-driven technical fields. With the approval of the Undergraduate Program Director, students may substitute the 15 semester hours of PH 420, PH 432, PH 445, PH 461, and PH 450 with a mix of physics, computer science, and engineering courses that best aligns with their professional goals.

Requirements		Hours
PH 103	Understanding the World Through Data	3
PH 104	Community Data Research	3
PH 299/491	Reasoning through Modeling and Simulation of Data	3
PH 418	Machine Learning Applications in Physics and Materials Science	3
PH 423	Computational Physics	3
PH 437	Digitally-Assisted Additive Manufacturing Technologies	3
PH 438	Data-driven Discovery, Synthesis, and Analysis [1]	3
or PH 492	Advanced Physics Laboratory II	
or PH 493	Advanced Physics Laboratory III	
or PH 495	Honors Research	
Total Hours		**21**

1 PH 492, PH 493, or PH 495 course offerings that include data-driven research projects may substitute for PH 438 course requirement.

2 PH 201 and PH 202 may substitute for PH 221 and PH 222.

3 PH 299/PH 491 may substitute for MA 227

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.

Proposed Program of Study for a Major 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 Mentor to select your Concentration Electives. Please consult with the Physics Academic Advisor **to add the courses required by the Blazer 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).

Freshman			
First Term	**Hours**	**Second Term**	**Hours**
PH 110		1 PH 221*	4
MA 225 or 125		4 MA 226 or 126	4

CH 115	3	CH 117	3
CH 116	1	CH 118	1
CAS 112 (or HC Seminar)	3	EH 102	3
EH 101	3		
	15		**15**

Sophomore

First Term	Hours	Second Term	Hours
PH 222*	4	PH 223	4
MA 252	3	MA 227	4
MA 260	3	PH 103†	3
PH 104†	3	PH 299†	3
Blazer Core	3		
	16		**14**

Junior

First Term	Hours	Second Term	Hours
PH 350	4	PH 432	3
PH 420	3	PH 418†	3
PH 461	3	Concentration or General Elective	3
Concentration or General Elective	2	Concentration or General Elective	3
Blazer Core	3	Blazer Core	3
	15		**15**

Senior

First Term	Hours	Second Term	Hours
PH 445	3	PH 499	3
PH 450	3	Minor Course(s) - usually math	3
PH 437†	3	Concentration or General Elective	3
Concentration or General Elective	3	Concentration or General Elective	3
Concentration or General Elective	3	Concentration or General Elective	3
	15		**15**

Total credit hours: 120

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

† *Recommended for the Certificate in Data-Driven Modeling*

Minor in Physics

Requirements		Hours
Required Physics Courses		
PH 221	General Physics I [1]	4
PH 222	General Physics II [1]	4
PH 223	General Physics III: Thermodynamics & Quantum Physics	4
Physics Electives		
Select 6 hours from the following:		6
PH 350	Computation, Theory, and Measurement in Quantum Physics and Relativity	
PH 418	Machine Learning Applications in Physics and Materials Science	
PH 420	Mathematical Methods of Physics I	
PH 423	Computational Physics	
PH 432	Statistical Thermodynamics I	
PH 437	Digitally-Assisted Additive Manufacturing Technologies	
PH 438	Data-driven Discovery, Synthesis, and Analysis	
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 481	Laser Physics I	
PH 482	Laser Physics II	
PH 487	Nanoscale Science and Applications	
Total Hours		**18**

[1] PH 221 General Physics I and PH 222 General Physics II 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:

- arrangement with a faculty sponsor to do a physics research project satisfying expectations for six semester hours of PH 495 Honors Research
- selection of an Honors Committee.
- committee approval of a research proposal.
- 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

This 15-hour certificate is *open to all majors* and is designed to enhance their training and education by equipping students with key critical data modeling skills. The five required courses form a coherent sequence of increasing complexity. They are integrated through the gradual introduction of data processing concepts and Python programming. Students also get real-world, experiential learning opportunities in Birmingham that allow them to test and apply their skills.

Undergraduate Certificate in Data-Driven Modeling

Requirements		Hours
PH 103	Understanding the World Through Data	3
PH 104	Community Data Research	3
PH 299	Reasoning through Modeling and Simulation of Data	3
PH 418	Machine Learning Applications in Physics and Materials Science	3
PH 437	Digitally-Assisted Additive Manufacturing Technologies	3
Total Hours		**15**

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 Quantitative Literacy 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 data. 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 (MA 168 [Min Grade: C] or MA 168 [Min Grade: P]) 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] or PH 221 [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. PH 221 General Physics I – Honors: This section of PH 221 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. 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 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]

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]

PH 350. Computation, Theory, and Measurement in Quantum Physics and Relativity. 4 Hours.
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.
Vector calculus. Curvilinear coordinate systems. Commonly encountered ordinary differential equations and special functions. Complex variables and contour integration. Partial differential equations, including solutions by Green function methods.
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.
Vector calculus. Curvilinear coordinate systems. Commonly encountered ordinary differential equations and special functions. Complex variables and contour integration. Partial differential equations, including solutions by Green function methods.
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.
Applied geometrical and wave optics. Paraxial ray optics, optical matrix theory, aberrations, optical imaging systems, and computer-based optical design. Optical interferometry, diffraction, holography, polarization phenomena, coherence theory, lasers, and Gaussian beam propagation.
Prerequisites: PH 222 [Min Grade: C]

PH 426. Applications of Contemporary Optics II. 3 Hours.
Applied geometrical and wave optics. Paraxial ray optics, optical matrix theory, aberrations, optical imaging systems, and computer-based optical design. Optical interferometry, diffraction, holography, polarization phenomena, coherence theory, lasers, and Gaussian beam propagation.
Prerequisites: PH 425 [Min Grade: C]

PH 427. Geometrical Optics. 4 Hours.
Properties of optical systems. Lenses, mirrors, and stops. Aberrations. Rays and wave fronts. Optical instruments. Aspheric components. Lecture and laboratory must be taken concurrently.
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.
Interference and diffraction phenomena. Emission, propagation, and absorption of radiation. Polarization and dispersion. Stimulated emission. Lecture and laboratory must be taken concurrently.
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 437. Digitally-Assisted Additive Manufacturing Technologies. 3 Hours.
This course introduces the principles and practices of digitally-assisted additive manufacturing, with an emphasis on the integration of physics-based models and data-driven approaches to design, process control, and optimization. Students will gain hands-on experience with 3D printing technologies while exploring methods such as Gaussian process modeling and Bayesian optimization for process parameter tuning. The course bridges fundamental physics of materials with machine learning and optimization strategies, preparing students to apply computational tools to marketplace and research challenges.
Prerequisites: PH 418 [Min Grade: C]

PH 438. Data-driven Discovery, Synthesis, and Analysis. 3 Hours.
This course offers a hands-on and data-driven exploration of modern approaches in materials discovery, synthesis, and characterization using instrumentation control, machine learning, and spectral imaging. Students will learn how to perform experiments in automated environments, apply Gaussian Process-based Bayesian Optimization (GPBO) to accelerate materials parameter search, leverage large materials databases for property prediction, and use spectroscopic imaging and emission spectra for characterization and feedback. The course integrates automated experimental platforms, computational modeling, and experimental methods to train students in closed-loop workflows for discovering, optimizing, and understanding advanced materials.
Prerequisites: PH 418 [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 456. Instrumentation for Scientists. 4 Hours.
An emphasis on the principles and execution of experimental instrumentation/techniques involving acquisition and interpretation of data. Basic skills related to use of critical laboratory instrumentation such as multimeters, oscilloscopes, control systems, vacuum systems, advanced microscopes, lasers, and spectrometers will lead to understanding and practical use of more advanced instrumentation designed for cutting-edge technologies in advanced materials development, information technology, biomedical technologies, and quantum science.

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 222 [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 tunablelasers. 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]

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]

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]

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]

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]

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]

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.

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

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]

PHS-Physical Sciences Courses

PHS 101. Physical Science. 4 Hours.
Scientific method and hands-on experience with integrated laboratory, discussion, and lecture. Emphasis on the use of quantitative reasoning to solve physical problems. Writing, assignments based on research and laboratory experiences that include collection and interpretation of experimental data. For nonscience majors. Lecture and laboratory. Writing and Quantitative Literacy are significant components of this course. This course meets Blazer Core Scientific Inquiry with a Flag in High Impact Practices/Collaborative Assignments and Projects.

PHS 101L. Physical Science Laboratory. 0 Hours.
Must be taken concurrently with PHS 101 lecture.

PHS 102. Physical Science II. 4 Hours.
This course includes online lecture and laboratory activities and is designed to assist non-science major students in acquiring practical knowledge of established physical laws and learning scientific investigative methods. Writing and Quantitative Literacy are significant components of this course. This course meets Blazer Core Scientific Inquiry with a Flag in High Impact Practices/Collaborative Assignments and Projects.
Prerequisites: PHS 101 [Min Grade: C]

PHS 102L. Physical Science II Lab. 0 Hours.
Physical Science II Laboratory.

PHS 110. Overview of Space Exploration. 3 Hours.
Descriptive approach to comparative planetology for non-science majors. Analysis of recent, ongoing, and planned space missions with regard to scientific objectives and experiment design.

PHS 141. Musical Acoustics. 3 Hours.
Scientific method and hands-on experience with integrated laboratory, discussion, and lecture, emphasizing physical principles and experiences important for understanding musical tones. For non-science majors. See MU 141. Prerequisite for this class includes completion of Core Curriculum mathematics requirement.

PHS 150. Science Writing. 3 Hours.
Scientific writing skills for science, mathematics, and engineering. Identification of audience and purpose, generation of ideas, organization of information and construction of arguments.

PHS 211. Discussion on the Nature of Matter. 3 Hours.
Honors seminar. Evolution of science and scientific method from early Greek origins in context of the study of matter. Non-mathematical, descriptive, and pictorial approach to understanding basic structure of matter and materials of technological interest. See HON 211. Scientific writing skills for science, mathematics, and engineering. Permission of instructor or admission to Honors Program.