PROGRAM IN PHYSICS

Ian Bentley, Program Director
B07 Science Hall
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FACULTY

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PROGRAM DESCRIPTION

The program in physics allows students to investigate the microscopic and the macroscopic through courses covering topics such as astronomy, nuclear physics, classical mechanics, modern physics, and quantum mechanics.

The B.S. in Physics is a curriculum designed to prepare students for graduate school in physics. The B.S. in Physics also provides adequate preparation for traditional physics professions in the private sector, the military, academia and national laboratories. Physicists work in industries including construction, education, energy, defense, finance, law, medical, music, space, sports, television, transportation, and even video game development.

The B.A. in Physics is highly flexible, making it possible to combine studies in physics with other programs, thereby supporting careers in biophysics, computational modeling, economic modeling, history of science, medicine, philosophy of science, physical chemistry and teaching high school science.

For those interested in a career in aerospace, structural civil, electrical, or mechanical engineering, the degrees offered in Physics, both B.A. and B.S., nicely complement the Five-Year Dual Degree Program in Engineering with the University of Notre Dame.

PROGRAM LEARNING OUTCOMES

Upon graduation, students will be able to:

- **create** a conceptual framework for modeling a system using laws of nature, physical principles, and other practical constraints.
- **produce** concise solutions to physical problems.
- **apply** knowledge of physics and mathematics to real world situations.
- **demonstrate** essential research skills including: practicing laboratory safety and performing error analysis.
- critically **evaluate** scientific literature.
- effectively **communicate** scientific results.

SENIOR COMPREHENSIVE

The Senior Comprehensive requirement in Physics is fulfilled by successfully completing two presentations, one in a poster format and one 15 minute oral presentation. Both are given in the second semester of the senior year and include a question and answer period with faculty. The topic of the presentation may be based on experimental laboratory research performed at Saint Mary's or at another institution, or literature research on an approved topic. Emphasis is placed on explaining the physics of the research. An abstract of the topic is also required prior to the oral presentation.

ADVANCED WRITING PROFICIENCY

Each student writes a formal paper consisting of a technical discussion of the relevant physical principles, mathematics and methods related to her oral comprehensive presentation. These are normally submitted during the first semester of the senior year.

PROGRAM IN PHYSICS

Bachelor of Science, Major in Physics—PHYS (60 hours)

All of the following:

PHYS 121	General Physics I	lab	4 hours
PHYS 122	General Physics II	lab	4 hours
PHYS 253	General Physics III		3 hours
PHYS 323	Classical Mechanics		3 hours
PHYS 343	Thermodynamics		3 hours
PHYS 424	Quantum Mechanics		3 hours
PHYS 444	Electricity and Magnetism		3 hours

Two of the following:

PHYS 272L	Computational Physics Laboratory	lab	1 hour
PHYS 282L	Modern Experimental Laboratory	lab	1 hour
PHYS 292L	Wave Mechanics Laboratory	lab	1 hour

Required Supporting Courses:

CHEM 121	Principles of Chemistry I	lab	4 hours
CHEM 122	Principles of Chemistry II	lab	4 hours
CPSC 207	Computer Programming		3 hours
MATH 131-132	Calculus I, II		8 hours
or MATH 133	Theory and Application of Calculus		4 hours
MATH 231	Calculus III		4 hours
MATH 326	Linear Algebra and Differential Equations		4 hours

Two of the following:

CHEM 221	Organic Chemistry I		3 hours
CHEM 222	Organic Chemistry II		3 hours
CPSC 315	Simulation: Theory and Application		3 hours
CPSC 328	Data Structures		3 hours
MATH 335	Differential Equations II		3 hours
MATH 336	Numerical Analysis		3 hours
MATH 345	Probability		3 hours
MATH 346	Statistics		3 hours
PHYS 215	Materials Science		3 hours
PHYS 232	Astrophysics		3 hours
PHYS 235	Nuclear Physics		3 hours

Additional technical electives in science, computer science, mathematics, or engineering to total 60 credit hours.

Bachelor of Arts, Major in Physics—PHYS (37–41 hours)

All of the following:

PHYS 121	General Physics I	lab	4 hours
PHYS 122	General Physics II	lab	4 hours
PHYS 253	General Physics III		3 hours

Two of the following:

PHYS 272L	Computational Physics Laboratory	lab	1 hour
PHYS 282L	Modern Experimental Laboratory	lab	1 hour
PHYS 292L	Wave Mechanics Laboratory	lab	1 hour

Three of the following:

PHYS 323	Classical Mechanics	3 hours
PHYS 343	Thermodynamics	3 hours
PHYS 424	Quantum Mechanics	3 hours
PHYS 444	Electricity and Magnetism	3 hours

One additional 200+ level PHYS course.

Required Supporting Courses:

MATH 131-132	Calculus I, II	8 hours
or MATH 133	Theory and Application of Calculus	4 hours
MATH 231	Calculus III	4 hours
MATH 326	Linear Algebra and Differential Equations	4 hours

Minor in Physics—PHYS (17 hours)

All of the following:

PHYS 121	General Physics I	lab	4 hours
or PHYS 111	College Physics I	lab	4 hours
PHYS 122	General Physics II	lab	4 hours
or PHYS 112	College Physics II	lab	4 hours

Three of the following:

PHYS 215	Materials Science	3 hours
PHYS 232	Astrophysics	3 hours
PHYS 235	Nuclear Science	3 hours
PHYS 253	Modern Physics	3 hours
PHYS 323	Classical Mechanics	3 hours
PHYS 343	Thermodynamics	3 hours
PHYS 424	Quantum Mechanics	3 hours
PHYS 444	Electricity and Magnetism	3 hours

PHYSICS COURSES (PHYS)

101 Introductory Topics in Physics: Motion (4)
An introduction to concepts, applications, and history of physics via exploration of everyday motion. The primary goal of this conceptually-based course is to convey an understanding of science as a way of viewing the natural world. The laboratory introduces fundamental principles of scientific investigation via experimental exploration. This course is intended for students not majoring in science. (Three hours lecture and a two-hour laboratory). Prerequisite: None.

102 Introductory Topics in Physics: Energy (4)
An introduction to concepts, and applications of physics through the lens of energy. This course deals with the science of national and global energy concerns. The laboratory introduces fundamental principles of scientific investigation via experimental exploration. This course is intended for students not majoring in science. (Three hours lecture and a two-hour laboratory). Prerequisite: None.

104 Introductory Physics (3)
An introduction to concepts and applications of physics via an overview of topics in physics chosen from motion, energy, wave phenomena, optics, or other basic physics themes. The primary goal of this course is to convey an understanding of science as a way of viewing the natural world. The course will require some basic algebra. (Three hours lecture). Prerequisite: None.

105 Astronomy (3)
A study of stars and galaxies within the Universe from our Earth based perspective. Scientific techniques and the history of scientific observation are included in addition to the properties of light and gravity. This course is intended for students not majoring in science or mathematics. (Three hours lecture). Prerequisite: None.

111 College Physics I: Mechanics and Waves (4)
An introduction to mechanics, and waves. This is the first semester of a two-part algebra-based physics sequence designed primarily for students in life-sciences (biology, and neuroscience), communications sciences and disorders, and environmental studies. (Three hours of lecture and two hours laboratory.). Prerequisite: MATH 103.

112 College Physics II: Temperature, Electricity, and Light (4)
An introduction to thermodynamics, electricity, magnetism, and optics. This is the second semester of a two-part algebra-based physics sequence designed primarily for students in life-sciences (biology, and neuroscience), communications sciences and disorders, and environmental studies. (Three hours of lecture per week and a two-hour laboratory.) Prerequisite: PHYS 111.

121 General Physics I: Mechanics and Waves (4)
An introduction to mechanics, and waves. This is the first semester of a two-part calculus-based physics sequence designed for students in science, math, and engineering. (Three hours of lecture and two hours laboratory.) Prerequisite: either MATH 131, 132, or 133. (High school physics strongly recommended)

122 General Physics II: Temperature, Electricity, and Light (4)
An introduction to thermodynamics, electricity, magnetism, and optics. This is the second semester of a two-part calculus-based physics sequence designed for students in science, math, and engineering. (Three hours of lecture per week and a two-hour laboratory.) Prerequisite: PHYS 121; and either MATH 132 or 133.

215 Materials Science(3)
A study of material properties at the intersection of physics, chemistry and engineering. Materials such as polymers, ceramics, and metals will be explored. This physics elective is intended for students interested in science and engineering. (Three hours lecture). Prerequisites: PHYS 122 and CHEM 122.

232 Astrophysics (3)
A study of early astronomical observations involving celestial mechanics. The nature of light, and the interaction of light with matter will be discussed. Star formation and the processes by which stars end their life-cycle will also be covered including neutron stars, black holes and supernovae. This physics elective is intended for students interested in science and engineering. (Three hours lecture). Prerequisite: PHYS 122.

235 Nuclear Physics (3)
A study of the scientific, mathematical, and ethical issues concerning topics from nuclear physics. Concepts in nuclear medicine, nuclear power and nuclear weapons are discussed in detail. This physics elective is intended for students interested in science and engineering. (Three hours lecture). Prerequisites: PHYS 122 and CHEM 122.

253 General Physics III: Modern Physics (3)
An introduction to the conceptual and mathematical foundations of elementary quantum physics, and the historical framework and methodology of twentieth century physics, including contributions of women scientists. Special relativity and atomic physics are also discussed. (Three hours lecture). Prerequisite: PHYS 112 or 122 and MATH 231.

272L Computational Physics Laboratory (1)
Computational methods in physics are explored. This course covers computational topics in physics, primarily in astrophysics and nuclear physics/quantum mechanics. Offered in the spring on a three-year rotation. (Three hours laboratory). Prerequisite: PHYS 122.

282L Modern Experimental Laboratory (1)
Experimental methods in physics are explored. This course covers experimental topics primarily from modern physics and materials science. Offered in the spring on a three-year rotation. (Three hours laboratory). Prerequisite: PHYS 122.

292L Wave Mechanics Laboratory (1)
Laboratory methods in physics are explored. This course covers experimental and computational topics related to wave mechanics. Offered in the spring on a three-year rotation. (Three hours laboratory). Prerequisite: PHYS 122.

321 Lagrangian Mechanics (1)
This course will cover topics in classical mechanics including wave motion. The primary focus is the Lagrange formalism which is used to setup simple differential equations and solve for equations of motion. This course covers the same material as PHYS 323 but only lasts for the first third of the semester. This course is intended for students who are also required to take additional courses in mechanics. Typically offered fall of even-numbered years. (Three hours lecture). Prerequisite: PHYS 253.

323 Classical Mechanics (3)
A detailed study of classical mechanics including Newton's laws, and conservation laws. Equations of motion are derived based on the Lagrange and Hamiltonian formalisms. Typically offered fall of even-numbered years. (Three hours lecture). Prerequisite: PHYS 253.

341 Statistical Mechanics (1)
This course will cover topics in thermodynamics from a statistical mechanics viewpoint. Systems containing large numbers of particles will be analyzed using Boltzmann statistics. This course covers the same material as PHYS 343 but only lasts for the first third of the semester. This course is intended for students who are also required to take additional courses in Thermodynamics. Typically offered fall of odd-numbered years. (Three hours lecture). Prerequisite: PHYS 253.

343 Thermodynamics (3)
A detailed study of statistical mechanics and thermodynamics. Systems containing large numbers of particles will be analyzed using Boltzmann statistics. The laws of thermodynamics will be introduced. Cyclic processes and other thermodynamic concepts will be developed. Typically offered fall of even-numbered years. (Three hours lecture). Prerequisite: PHYS 253.

424 Quantum Mechanics (3)
A detailed physical and mathematical study of quantum mechanics including wave mechanics. Physical applications of quantum mechanics are also discussed. Typically offered fall of even-numbered years. (Three hours lecture). Prerequisites: PHYS 253 and MATH 326.

444 Electricity and Magnetism (3)
A detailed physical and mathematical study of electricity and magnetism focusing on applications from vector calculus. Interactions between electric and magnetic fields are explored including the use of Maxwell's equations. Typically offered fall of odd-numbered years. (Three hours lecture). Prerequisites: PHYS 253 and MATH 326.

460 Mathematical Methods (3)
An introduction of mathematical topics including vector calculus, differential equations, probability and statistics. These topics are often of interest to scientist and engineers. Offered based on student demand. (Three hours lecture). Prerequisites: PHYS 253 and MATH 326.