

PHYSICS

Chair: Jim Crumley

Faculty: Jim Crumley, Greg Taft, Todd Johnson, Dean Langley, Adam Whitten, Sarah Yost

The program of study at Saint Benedict's and Saint John's is planned to keep students abreast of the latest developments in the study of physics. The curriculum covers the basics of classical and modern physics, examining human understanding of nature from elementary particles to the cosmos.

Physics majors choose from a sequence of courses that can give them excellent preparation for graduate school, industrial research, secondary teaching or professional studies such as engineering, law and medicine.

For majors in the other sciences, PHYS 105 Physics for the Life Sciences I, PHYS 106 Physics for the Life Sciences II and PHYS 191 Foundations of Physics I, PHYS 200 Foundations of Physics II and PHYS 211 Foundations of Physics III offer an introduction to the principles of physics at different mathematical levels: PHYS 105 Physics for the Life Sciences I and PHYS 106 Physics for the Life Sciences II make use of high school level algebra, geometry and trigonometry; PHYS 191 Foundations of Physics I, PHYS 200 Foundations of Physics II and PHYS 211 Foundations of Physics III assume concurrent registration in calculus and linear algebra.

Physics is a valuable study for non-science majors, too. The department offers courses (ASTR 111 Solar System, ASTR 112 Stellar Universe, PHYS 101 Perspectives in Physics, PHYS 102 Light and Color, PHYS 110 The Physics of Forensics, PHYS 150 The Physics of Music, and PHYS 187 Introduction to Meteorology) which have been developed specifically to suit the needs of non-science majors. No previous introduction to physics is necessary, and mathematics is used sparingly.

The department's experimental facilities include gamma-ray analyzers, a 3-D printer, a diffusion pump vacuum system, a variety of lasers, fiber-optics, holography and interferometry equipment, an all-sky camera, and many other instruments. Computing facilities include Microsoft Windows and Linux computers in laboratories and classrooms, including a computing lab containing dual screen computers.

The department also maintains shop facilities for metal and woodworking, and an electronics shop. Students are encouraged to work independently. Many select their own experimental projects, build special apparatus and perform original measurements.

Assessment

The Physics Department takes several steps to ensure that we are doing a good job of preparing our students; seniors take the Major Field Test in physics, for example, and those planning on graduate school take the graduate record exam in physics. Overall, however, we believe that the performance of our students after they leave us is the most telling measure of the effectiveness of our program. Our students go on to engineering schools, graduate schools in physics and engineering, government and industrial laboratories, and the like. We do our best to keep in touch with our former students, find out how well they are doing and how good a job we have done of preparing them. We use this information, among other sources, in periodic reviews of our program.

Acceptance to Major Requirements

Course Requirements: PHYS 191, 200, 211, 332, MATH 120 and 239
Minimum Grade and/or GPA for required courses: 2.00 GPA
Minimum Cumulative GPA: 2.00

Majors

- Physics Major (<https://catalog.csbsju.edu/catalog/academic-departments/physics/physics-major-/>)
- Physics Major with a Concentration in Engineering Physics (<https://catalog.csbsju.edu/catalog/academic-departments/physics/physics-major-concentration-engineering/>)
- Physics Major - Secondary Education (<https://catalog.csbsju.edu/catalog/academic-departments/physics/physics-major-secondary-education/>)

Minors

- Physics Minor (<https://catalog.csbsju.edu/catalog/academic-departments/physics/physics-minor/>)

ASTR 111 Solar System (4 Credits)

The sun and its satellites. Historical development of basic concepts. Present space exploration.

Prerequisites: None

Corequisites: ASTR 111L

Equivalent courses: ASTR 211

Attributes: Natural World (NW), Quantitative Reasoning (QR), Thematic Encounter1/2 - Truth

ASTR 111L Laboratory (0 Credits)

Prerequisites: None

Corequisites: ASTR 111

Equivalent courses: ASTR 211L

ASTR 112 Stellar Universe (4 Credits)

Properties of stars and their grouping. Milky Way Galaxy. Universe of galaxies. Cosmologies.

Prerequisites: None

Corequisites: ASTR 112L

Equivalent courses: ASTR 212

Attributes: Natural World (NW), Quantitative Reasoning (QR), Thematic Encounter1/2-Movement

ASTR 112L Laboratory (0 Credits)

Prerequisites: None

Corequisites: ASTR 112

Equivalent courses: ASTR 212L

ASTR 213 Night Sky Astronomical Observatory (1 Credit)

Constellations. Survey of deep sky objects using binoculars and telescope.

Prerequisites: None

ASTR 271 Individual Learning Project (1-4 Credits)

Supervised reading or research at the lower-division level. Permission of department chair required. Not available to first-year students.

Prerequisites: None

PHYS 101 Perspectives in Physics (4 Credits)

An introduction to the scientific enterprise: the course will treat selected issues in physics, their historical development and their effect on literature, philosophy and society at large. Topics might include Newtonian mechanics, optics, quantum physics and electromagnetism. Lectures, demonstrations, discussion, occasional laboratories. Intended for non-science majors.

Prerequisites: None

PHYS 102 Light and Color (4 Credits)

An introduction to optics, the science of light and color. A broad range of topics will be examined. Subject matter may include: rainbows and the color of the sky, vision and the eye, optical instruments, photography, wave aspects of light, lasers and holography. A background in physics or mathematics is not necessary.

Prerequisites: None

Corequisites: PHYS 102L

PHYS 102L Laboratory (0 Credits)

Prerequisites: None

Corequisites: PHYS 102

PHYS 105 Physics for the Life Sciences I (4 Credits)

An introduction to mechanics and thermodynamics emphasizing applications to biological systems. Topics include Newton's laws of motion, equilibrium, torques, forces, conservation principles, work, energy, power, rotating systems, oscillations, temperature, heat transfer, laws of thermodynamics, fluid statics and dynamics. Intended for non-majors. Algebra and trigonometry are needed. Recommended: MATH 115 or equivalent high school mathematics. Fall and Spring.

Prerequisites: None

Corequisites: PHYS 105L

Equivalent courses: PHYS 105AC, PHYS 105Z

Attributes: Natural World (NW), Quantitative Reasoning (QR), Thematic Encounter1/2-Movement

PHYS 105L Laboratory (0 Credits)

Prerequisites: None

Corequisites: PHYS 105

PHYS 106 Physics for the Life Sciences II (4 Credits)

An introduction to electricity and magnetism, wave phenomena, atomic and nuclear physics emphasizing applications to biological systems. Topics include electric and magnetic forces and fields, direct and alternating current circuits, light, sound, optical instruments, relativity, quantum physics, atomic spectra, nuclear physics, radioactivity. Intended for non-majors. Fall and Spring.

Prerequisites: PHYS 105 or PHYS 105Z or PHYS 105AC

Corequisites: PHYS 106L

Equivalent courses: PHYS 106AC, PHYS 106Z

Attributes: Natural World (NW), Thematic Encounter1/2 - Truth

PHYS 106L Laboratory (0 Credits)

Prerequisites: None

Corequisites: PHYS 106

PHYS 110 The Physics of Forensics (4 Credits)

An introduction to some forensics techniques, and the physics behind the techniques. The forensic techniques will also be discussed in context of the criminal justice system. Forensic topics such as ballistics, structural failure, blood spatter and spectrometry will be covered. Physics background will include motion, forces, energy, momentum, waves, light, and nuclear physics. Recommended: Math 115 or equivalent.

Prerequisites: None

Corequisites: PHYS 110L

Equivalent courses: PHYS 152

Attributes: Natural World (NW), Quantitative Reasoning (QR), Thematic Encounter1/2-Justice

PHYS 110L Laboratory (0 Credits)

Prerequisites: None

Corequisites: PHYS 110

PHYS 150 The Physics of Music (4 Credits)

Relationships between music and physics. Sound sources and modes of oscillation, sound as a wave phenomenon and the characterization of sound; scales and keyboard temperament, auditorium and room acoustics; the physics of musical instruments and particular tone color effects in these instruments; electronic sound production, recording and electronic music synthesis. Intended for non-science majors.

Prerequisites: ACT Math with a score of 21 or SAT Mathematics with a score of 530 or Quantitative Skills Inventory with a score of 25

Corequisites: PHYS 150L

Attributes: Natural World (NW), Quantitative Reasoning (QR), Thematic Encounter1/2-Movement

PHYS 150L Laboratory (0 Credits)

Prerequisites: None

Corequisites: PHYS 150

PHYS 155 Introduction to Engineering (2 Credits)

An introduction to the field of engineering and the processes and principles engineers use. Engineering will be explored and practiced through solving problems and completing projects. The place of engineering in society and the types of engineering will also be discussed. Recommended: Math 115 or equivalent. Spring.

Prerequisites: None

PHYS 163 Environmental Radiation (4 Credits)

An introduction to nuclear radiation in the environment from natural and man-made sources. Topics include fundamentals of nuclear structure, stability, effects of radiation on matter, radiation detection, characteristics of natural, industrial, medical, and military radiation sources, environmental mobility, and radiation protection practices and policies. Recommend Math proficiency, high school biology, chemistry, or physics.

Prerequisites: None

PHYS 187 Introduction to Meteorology (4 Credits)

A survey of the basic principles involved in understanding the earth's weather and climate. Topics include winds, fronts, cyclones, clouds and precipitation, thunderstorms, tornadoes and hurricanes, climate and climate change, global warming and ozone depletion. Prerequisite: Math proficiency. Corequisite: PHYS 187L.

Prerequisites: None

Corequisites: PHYS 187L

Attributes: Natural World (NW), Quantitative Reasoning (QR), Thematic Encounter1/2-Movement

PHYS 187L Laboratory (0 Credits)**Prerequisites:** None**Corequisites:** PHYS 187**Attributes:** Natural World (NW), Quantitative Reasoning (QR)**PHYS 191 Foundations of Physics I (4 Credits)**

Mechanics: vectors, Newton's laws, work, energy, rigid body statics and dynamics. A calculus-based course that emphasizes analytical reasoning and problem-solving techniques. Laboratory places stress on data acquisition and analysis. Prerequisite: concurrent registration in MATH 119. Fall.

Prerequisites: MATH 119 or MATH 119Z**Corequisites:** PHYS 191L**Equivalent courses:** PHYS 191Z**Attributes:** Natural World (NW), Quantitative Reasoning (QR), Thematic Encounter1/2-Movement**PHYS 191L Laboratory (0 Credits)****Prerequisites:** None**Corequisites:** PHYS 191**PHYS 200 Foundations of Physics II (4 Credits)**

Electric and magnetic fields and their sources, electric potential and electro-magnetic induction. DC and AC circuit elements and circuits. Electromagnetic waves. Emphasis on problem solving. A laboratory is included. Spring.

Prerequisites: (PHYS 191 or PHYS 191Z) and (MATH 120**Corequisites:** PHYS 200L**Equivalent courses:** PHYS 200Z**Attributes:** Natural World (NW), Thematic Encounter1/2 - Truth**PHYS 200L Laboratory (0 Credits)****Prerequisites:** None**Corequisites:** PHYS 200**PHYS 211 Foundations of Physics III (4 Credits)**

Thermodynamics and waves. Kinetic theory and the laws of thermodynamics are developed from a mechanical point of view. Temperature, entropy and heat engines. Wave phenomena (sound and light) are developed from a unified point of view. Geometrical optics. Fall.

Prerequisites: PHYS 200 and (MATH 239**PHYS 217 Digital Electronics (2 Credits)**

Introduction to digital electronics at the integrated circuit level; logic families, gates, counters, registers and memories.

Prerequisites: PHYS 200 or PHYS 200Z**Corequisites:** PHYS 217L**PHYS 217L Laboratory (0 Credits)****Prerequisites:** None**Corequisites:** PHYS 217**PHYS 222 C++ and Fortran for Scientists (2 Credits)**

C++ and Fortran language fundamentals with examples from numerical analysis. Topics may include scientific data analysis and curve fitting, simulation of physical systems and numerical algorithms for integration and matrix manipulation. .

Prerequisites: PHYS 200 and (MATH 120 or MATH 120Z)**PHYS 255 CAD Prototyping & Testing (2 Credits)**

An introduction to computer-aided design (CAD) software for designing and testing mechanical parts and systems. Students will learn to design and test solutions to mechanical engineering problems. Topics include creating solid bodies from 2D sketches, finite element analysis of structural integrity, and 3D printing of design prototypes. Fall.

Prerequisites: PHYS 191 or PHYS 105**PHYS 271 Individual Learning Project (1-4 Credits)**

Supervised reading or research at the lower-division level. Permission of department chair required. Consult department for applicability towards major requirements. Not available to first-year students.

Prerequisites: None**PHYS 281 Problem Solving (1 Credit)**

An introduction to solving complex problems in interdisciplinary topics which will be drawn from mathematics, computer science, and physics. Students will work in groups and present their results. Prerequisite: admission to Women in STEM program

Prerequisites: None**Equivalent courses:** CSCI 281, HONR 270C, MATH 281**PHYS 310 Special Topics in Physics (2 Credits)**

This course will apply basic calculus to topics on (1) linear and rotational kinematics, (2) forces, potential energy, fields, and potential, (3) conservation laws, (4) oscillations and waves, (5) electricity and magnetism, or (6) optics, kinetic theory, and modern physics. Must have completed PHYS 320 and 332 or 3 years high school science teaching experience.

Prerequisites: None**Restrictions:** Enrollment is limited to students with a minor in Elementary Education, Secondary Education or Secondary Education.**PHYS 310A Topics in Mechanics (2 Credits)**

Principles of mechanics including (1) linear and rotational kinematics, (2) forces, potential energy, fields, and potential, and (3) conservation laws. Onsite laboratory experiences include experiments on data analysis, the acceleration of gravity, projectile motion, Archimedes' Principle, rotational dynamics, the ballistic pendulum, and two-body collisions. Prerequisite: 3 years high school science teaching experience or education major who has completed PHYS 320 and PHYS 332.

Prerequisites: None**PHYS 310B Topics in Waves/Electromagnetism (2 Credits)**

Topics include oscillations and waves, electricity and magnetism, and laboratory experiments. Prerequisite: 3 years high school science teaching experience or education major who has completed PHYS 320 and PHYS 332.

Prerequisites: None**PHYS 310C Topics in Optics & Modern Physics (2 Credits)**

Topics include optics, kinetic theory, modern physics, and laboratory experiments. Prerequisite: 3 years high school science teaching experience or education major who has completed PHYS 320 and PHYS 332.

Prerequisites: None**PHYS 320 Modern Physics (4 Credits)**

Introduction to the ideas and mathematics of quantum theory. Bohr atom, kinetic theory, black body radiation, quantum mechanics in the Schrödinger representation. Applications of quantum mechanics to selected topics in atomic, molecular or other areas of modern physics. Spring.

Prerequisites: PHYS 211**PHYS 322 C++ and Fortran for Scientists (2 Credits)**

C++ and Fortran language fundamentals with examples from numerical analysis. Topics may include scientific data analysis and curve fitting, simulation of physical systems and numerical algorithms for integration and matrix manipulation. Identical to PHYS 222 except for additional required programming project.

Prerequisites: PHYS 200 and (MATH 120 or MATH 120Z)

PHYS 332 Intermediate Physics Laboratory (1 Credit)

Experimentation for sophomores. Quantitative measurements and analysis of data. Research approach is emphasized. May be repeated for credit when different experiments are done.

Prerequisites: PHYS 211 (may be taken concurrently) or PHYS 320 (may be taken concurrently)

Equivalent courses: PHYS 332Z

PHYS 338 Analog Electronics for Scientists (2 Credits)

Circuit theory, transistors, amplifiers, laboratory test equipment and integrated circuits.

Prerequisites: PHYS 200 or PHYS 200Z

Corequisites: PHYS 338L

PHYS 338L Laboratory (0 Credits)

Prerequisites: None

Corequisites: PHYS 338

PHYS 339 Physical Mechanics (4 Credits)

The dynamics of particles and systems. Gravitational theory, particle oscillations, Hamilton's principle, Lagrangian and Hamiltonian dynamics, central force motion, rigid body motion, collisions, non-inertial reference frames, coupled oscillations. Fall.

Prerequisites: MATH 305, PHYS 211 Learning Foundations(LF), Cultural and Social Difference: Identity (CI). CI course may be taken prior to or concurrently with Focus Course.

Corequisites: PHYS 370

Attributes: Natural World (NW), Thematic Encounter3 - Movement

PHYS 341 Electricity and Magnetism (4 Credits)

Electrostatic potentials and fields in vacuum and dielectric media, magnetic vector potentials and fields in vacuum and magnetic materials, electrostatic and magnetic energies, slowly varying currents. Spring.

Prerequisites: PHYS 339

PHYS 343 Thermodynamics (2 Credits)

Foundations of thermodynamics and applications. Spring.

Prerequisites: PHYS 320

PHYS 344 Statistical Mechanics (2 Credits)

Foundations of statistical mechanics. Applications to condensed matter systems, classical and quantum gases. Spring.

Prerequisites: PHYS 320 and PHYS 339

PHYS 346 Quantum Mechanics I (4 Credits)

Foundations of quantum theory, wave packets, Schrödinger's equation in one dimension, raising and lowering operators. Formal structure of quantum mechanics. Angular momentum and the hydrogen atom. Spring alternating years.

Prerequisites: PHYS 339 and MATH 305

PHYS 348 Advanced Theoretical Physics (2-4 Credits)

A continuation of 339, 341 and 346. Topics could include advanced Hamiltonian and Lagrangian mechanics, tensors, eigenvalue problems, small oscillation; Maxwell's equations, wave equation, radiation, antennas, waveguides; matrix methods in quantum mechanics, spin, perturbation theory, transitions, many-electron atoms. Spring.

Prerequisites: PHYS 339 and PHYS 341 and PHYS 346

PHYS 353 Applied Nuclear Physics (2 Credits)

Applications of the interaction of radiation with matter to nuclear detection techniques. Current measurement methods for charged and uncharged radiation.

Prerequisites: PHYS 320

Corequisites: PHYS 353L

PHYS 353L Laboratory (0 Credits)

Prerequisites: None

Corequisites: PHYS 353

PHYS 355 MATLAB for Physical Applications (2 Credits)

An introduction to the MATLAB programming language through the study of applications relevant to engineering and physics. The applications covered will be drawn from areas such as statics, fluid dynamics, and heat transfer. Spring.

Prerequisites: PHYS 320

PHYS 357 Experimental Optics (2 Credits)

Study of optical phenomena with emphasis on the needs of the experimentalist. Topics may include optical systems design, spectrum analysis, image processing, holography.

Prerequisites: PHYS 320

PHYS 357L Laboratory (0 Credits)

Prerequisites: None

Corequisites: PHYS 357

PHYS 358 Advanced Electronics (2 Credits)

Topics will be selected from the following in advanced analog and digital circuitry: active filters, precision circuits, low noise techniques, high frequency techniques, advanced microprocessor circuits, scientific instrumentation.

Prerequisites: PHYS 217 and PHYS 338

PHYS 358L Laboratory (0 Credits)

Prerequisites: None

Corequisites: PHYS 358

PHYS 362 Topics in Modern Physics (2 Credits)

The concepts and principles presented in 191 through 320 will be used to study specific areas of physics not available elsewhere in the curriculum. Subject matter will come from such areas as elementary particle, condensed matter, nuclear, atomic, molecular physics and cosmology. Topics will be announced.

Prerequisites: PHYS 320

PHYS 363 Topics in Nuclear Physics (2 Credits)

Fundamental structure and properties of nuclei. Nuclear reactions, models and decay. Examples taken from current medical and industrial applications.

Prerequisites: PHYS 320

PHYS 364 Topics in Astrophysics (2 Credits)

Selected topics in astrophysics. Such subjects as general relativity, cosmology, stellar formation and evolution and galaxies will be studied.

Prerequisites: PHYS 320 and MATH 239 and MATH 337

PHYS 365 Topics in Elementary Particle Physics (2 Credits)

Physics at the smallest known length scale. Topics will include relativistic particle decay, construction of baryons and mesons from quarks, the four fundamental interactions and corresponding gauge particles, the vision and consequences of grand unified theories, the cosmic onion.

Prerequisites: PHYS 320

PHYS 366 Topics in Relativity (2 Credits)

Foundations and application of the special and general theories of relativity. Topics covered may include: relativistic kinematics, structure of flat space-time, curvature and topologies of general space-times, Schwarzschild and Friedman solutions, cosmology, black holes and gravitational radiation.

Prerequisites: PHYS 320

PHYS 367 Optics (2 Credits)

An introduction to geometrical and physical optics: matrix optics, interferometry, thin films, Fourier optics, spatial filtering, holography.

Prerequisites: PHYS 320

PHYS 368 Topics in Space Physics (2 Credits)

Space physics is the study of plasma which fills the space between the Sun and planets of our solar system. The course will include an introduction to plasma physics, followed by a study of the atmosphere of the Sun, the solar wind, the Earth's magnetosphere, auroras, and space weather.

Prerequisites: PHYS 320

PHYS 370 Advanced Physics Laboratory (1 Credit)

Research and experimentation for juniors. Topics selected by the student in consultation with a faculty member. May be repeated for credit when different experiments are done.

Prerequisites: None

PHYS 371 Individual Learning Project (1-4 Credits)

Supervised reading or research at the upper-division level. Permission of department chair and completion and/or concurrent registration of 12 credits within the department required. Consult department for applicability towards major requirements. Not available to first-year students.

Prerequisites: None

PHYS 372 Senior Research (1 Credit)

Individualized experimental or theoretical projects for seniors. Fall.

Prerequisites: None

Attributes: Experiential Engagement (EX)

PHYS 373 Senior Thesis (1 Credit)

Oral and written report based on the work done in 372 or 374. Spring.

Prerequisites: PHYS 372 or PHYS 374

Attributes: Writing Requirement (WR)

PHYS 374 Senior Engineering Design Project (1 Credit)

Individualized engineering design project for seniors. Fall.

Prerequisites: None

Attributes: Experiential Engagement (EX)

PHYS 381 Research Seminar (1 Credit)

Solving complex problems in interdisciplinary topics which will be drawn from mathematics, computer science, and physics. Students will work in groups and present their results.

Prerequisites: PHYS 281

Equivalent courses: CSCI 381, HONR 340B, MATH 381

PHYS 397 Summer Internship (1-16 Credits)

Prerequisites: None