Physics

As the most basic of the physical sciences, physics can serve as the building block for many different careers. Using their understanding of physical principles, physicists have been at the forefront of many of the most exciting discoveries of the twentieth century and will continue to lead the way to many exciting discoveries in the future. They have contributed to a wide range of areas, including, but not limited to, biology, chemistry, communication, computer science, electronics, engineering, finance, managerial consulting, geophysics, medical physics, and transportation.

The SIU Carbondale Physics department focuses on applied physics. Therefore the department seeks to provide undergraduate students with the skills necessary to apply their basic understanding of physics to real-world problems for which the solutions are of near-future concern. With this in mind, the physics department at SIU offers a first-rate undergraduate program with four different specializations in applied physics-biomedical physics, computational physics, materials and nanophysics, and the traditional physics curriculum. These specializations are targeted to high-demand areas of science and take advantage of the expertise of our faculty. Members of the physics faculty are involved in a wide range of physics research projects, both theoretical and experimental, including low temperature physics, surface physics, materials physics, superconductivity, magnetism, synchrotron radiation, infrared spectroscopy, solid-state physics, quantum mechanics, quantum computation, computational physics, and statistical mechanics. Participation in faculty research projects by students is strongly encouraged and can be very useful to students since it provides them with faculty mentors, and experience applying learned skills to real-world physics problem-solving.

Physics is an exciting field; its graduates are in high demand and enjoy high salaries and job security. Employment opportunities in physics are varied and abundant, from industrial research and development to teaching. Physicists are employed by all sectors of society, including health care, various corporations, government, and universities. Students who wish to learn more are encouraged to contact the physics department directly or visit the department web site at physics.siu.edu.

A minimum GPA of 2.0 in all physics and mathematics course work is needed in order for a student to receive a degree in Physics. In terms of credit hour requirements toward a degree in Physics, a course will be counted only once. A student may not repeat a course or its equivalent in which a grade of B or better was earned without the consent of the department.

### Bachelor of Science Degree in Physics Requirements

<table>
<thead>
<tr>
<th>Degree Requirements</th>
<th>Credit Hours</th>
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<tbody>
<tr>
<td>University Core Curriculum Requirements</td>
<td>39</td>
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<tr>
<td>College of Science Academic Requirements</td>
<td>9</td>
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<tr>
<td>Biological Science (3 hours included in the UCC Life Science hours)</td>
<td>3</td>
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<tr>
<td>Degree Requirements</td>
<td>Credit Hours</td>
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<tr>
<td>Mathematics - completed with the major Physical Sciences</td>
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<td>- completed with the major Supportive Skills - CS 201 or CS 202 or CS 280 or CS 300;</td>
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<tr>
<td>ENGL 290 or ENGL 291 or ENGL 391; MATH 282 or MATH 483; 1 or 2 semesters of a foreign language</td>
<td>6</td>
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<tr>
<td>Physics Major Requirements</td>
<td>72</td>
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<tr>
<td>CHEM 200 or CHEM 200H, CHEM 201, CHEM 202 or CHEM 202H (3 hours included in the UCC Physical Science hours)</td>
<td>2</td>
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<tr>
<td>MATH 150, MATH 221, MATH 250, MATH 251, MATH 305, (3 hours included in the UCC Mathematics hours)</td>
<td>14</td>
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<tr>
<td>MATH 405 or MATH 406 or MATH 407 or MATH 409 or MATH 450 or MATH 475</td>
<td>3</td>
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<td>PHYS 100, PHYS 205A, PHYS 206A, PHYS 255A, PHYS 205B, PHYS 206B, PHYS 255B, PHYS 305, PHYS 301, PHYS 310, PHYS 320, PHYS 420, PHYS 430, PHYS 440, PHYS 445, PHYS 450</td>
<td>39</td>
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<tr>
<td>Physics electives from one of the following groups</td>
<td>14</td>
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<td>General Physics Electives PHYS 390, PHYS 424, PHYS 425, PHYS 428, PHYS 431, PHYS 432, PHYS 458, PHYS 470, PHYS 476, PHYS 490; CS 215, CS 220, CS 475, CS 476</td>
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<td>Computational Physics PHYS 476C; CS 202, CS 215, CS 220, plus electives from the General Physics list above to total 14 hours Not required: PHYS 450 (Three hours in lieu of PHYS 450) (Three hours included in UCC Supportive Skills)</td>
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<tr>
<td>Materials and Nanophysics PHYS 425, PHYS 476M plus electives from the General Physics list above to total 14 hours</td>
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<td>Biomedical Physics PHYS 476B; BIOL 211, BIOL 212, BIOL 213 Plus a minimum of 16 hours from the following Biomedical Physics Electives: CHEM 210, CHEM 211, CHEM 212, CHEM 340, CHEM 341, CHEM 350, CHEM 351 MICR 301, MICR 302, Not required: PHYS 440 and PHYS 450 (Six hours in lieu of PHYS 440 and PHYS 450) (Seven hours included in UCC and COS Biological/Life Sciences)</td>
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<td>Total</td>
<td>120</td>
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Physics Minor

A minor in physics requires 17 hours and must include PHYS 203A,B, and PHYS 253A,B, or PHYS 205A,B, and PHYS 255A,B, as well as PHYS 305 and PHYS 355 and five hours from any 300- or 400-level physics course except PHYS 470.

Physics Courses

**PHYS100 - Undergraduate Seminar** 100-1 Undergraduate Seminar. Lectures and discussions by students, faculty and invited guests on topics in physics. Will include discussions on employment opportunities, graduate school admission and undergraduate research. Graded: Pass/Fail.

**PHYS101 - Physics that Changed World** 101-3 Physics that Changed the World. (University Core Curriculum) [IAI course: P1 901L] This course will survey some of the most important developments in physics which have occurred over the past two millennia. Along the way, students will be introduced to fundamental physical principles such as energy conservation. Topics will include early astronomy, laws of motion, electricity, magnetism, waves, quantum mechanics and relatively. Lab fee: $20.

**PHYS102 - Everybody's Einstein** 102-1 Everybody's Einstein. A non-mathematical presentation of Einstein's relativity theories on a popular level. No prerequisite.

**PHYS103 - Astronomy** 103-3 Astronomy. (University Core Curriculum) Fundamental concepts of the physical sciences are used in the exploration of the observable universe. Studies include the history and techniques of astronomy, planets, stars, black holes, galaxies and cosmology. Lectures are supplemented by outdoor astronomical observations and/or indoor laboratory exercises. Lab fee: $20.

**PHYS201 - Introduction to Physics** 201-1 Introduction to Physics. Vectors (definitions, operations, etc.). Kinematics in one and two dimensions (including projectile motion). Newton's Laws of Motion. One hour of lecture and one hour of problem discussion per week. This course will be required for students wishing to enroll in PHYS 205A if they either: - have a score in a Physics placement test indicative of their need for having a course in these topics; or - if they have had no previous Physics classes.

**PHYS203A - College Physics** 203A-3 College Physics. (Advanced University Core Curriculum course) [IAI Course: P1 900] Mechanics, heat, and sound. Prerequisite: completing with grade C or better MATH 109 or 111 or 125 or 140 or 150. PHYS 203 A or B with PHYS 253 satisfies a Science Group I Core Curriculum requirement in lieu of PHYS 101 or 103.

**PHYS203B - College Physics** 203B-3 College Physics. (Advanced University Core Curriculum course) Electricity, magnetism, light, aspects of modern physics. Prerequisite: PHYS 203A. PHYS 203 A or B with PHYS 253 satisfies a Science Group I Core Curriculum requirement in lieu of PHYS 101 or 103.

**PHYS205A - University Physics** 205A-3 University Physics. (Advanced University Core Curriculum course) [IAI course: P2 900] Designed to meet requirements of physics, engineering and chemistry majors. Mechanics, heat and waves. Prerequisites: MATH 150 with grade of C or better. With PHYS 255A, satisfies the UCC Science Group I requirement instead of PHYS 101 or 103. Not for graduate credit.

**PHYS205B - University Physics** 205B-3 University Physics. (Advanced University Core Curriculum course) Designed to meet requirements of physics, engineering and chemistry majors. Electricity, magnetism and optics. Prerequisites: PHYS 205A and MATH 250 each with a grade of C or better. With PHYS 255B satisfies the UCC Science Group I requirement instead of PHYS 101 or 103. Not for graduate credit.

**PHYS206A - Problem Solving for PHYS 205A** 206A-1 Problem Solving for PHYS 205A. Students will learn tips and techniques for solving problems in 205A. This will be done in a problem-based learning environment by solving problems in groups with leadership from the instructor. Prerequisite: MATH 150 with a grade of C or better. Co-requisite: concurrent enrollment in PHYS 205A.
PHYS206B - Problem Solving for PHYS 205B 206B-1 Problem Solving for PHYS 205B. Students will learn tips and techniques for solving problems in 205A. This will be done in a problem-based learning environment by solving problems in groups with leadership from the instructor. Co-requisite: Concurrent enrollment in PHYS 205B. Prerequisite: MATH 150 with a grade of C or better.

PHYS253A - College Physics Lab 253A-1 College Physics Laboratory. (Advanced University Core Curriculum course) [IAI Course: P1 900L] One two-hour laboratory per week. Prerequisite: completion of or concurrent enrollment in 203A,B respectively; if the corresponding lecture course is dropped, the laboratory course must also be dropped. With 203A or B, satisfies the University Core Curriculum Science Group I requirement in lieu of PHYS 101 or 103. Lab fee: $25.

PHYS255A - University Physics Lab 255A-1 University Physics Laboratory. (Advanced University Core Curriculum course) [IAI Course: P2 900L] One two-hour laboratory per week. Prerequisite: completion of or concurrent enrollment in 205A,B respectively; if the corresponding lecture course is dropped, the laboratory course must also be dropped. With 205A or B, satisfies the University Core Curriculum Group I requirement in lieu of PHYS 101, 103. Lab fee: $25.

PHYS301 - Theoretical Methods 301-3 Theoretical Methods in Physics. Introduction to theoretical methods of general usefulness in intermediate and advanced undergraduate physics, with particular emphasis on applications of vector algebra and calculus, complex numbers, matrices, ordinary differential equations and Fourier series to selected topics in physics. Required of all physics majors prior to or concurrently taking 310 or 320. Prerequisite: PHYS 205A, MATH 250 with a grade of C or better.

PHYS302 - Astronomy-Honors 302-3 Astronomy - Honors. Current knowledge of the universe and the gathering of that knowledge. Includes properties of the solar system and theories of its origin, the structure and evolution of stars. Supplemented by occasional hours of evening observation. Prerequisite: one of PHYS 203A, 205A, plus MATH 111, or consent of instructor.

PHYS305 - Modern Physics 305-3 Modern Physics. (Advanced University Core Curriculum course) The physics of the twentieth century: special relativity (experimental basis; time dilation, length contraction, Lorentz transformations; addition of velocities; relativistic momentum, mass and energy). Quantum mechanics (wave-particle duality, early quantum theory, tunneling phenomena, the Schroedinger equation in one and in three dimensions). Applications of quantum theory to: atomic and molecular structure; lasers, condensed matter physics; nuclear and particle physics. Prerequisites: PHYS 205A and PHYS 205B with a grade of C or above, or PHYS 203A and PHYS 203B both with a grade of C or above.

PHYS310 - Mechanics 310-3 Classical Mechanics. Review of Newtonian mechanics of particles and rigid bodies, and Lagrangian and Hamiltonian dynamics. Prerequisite: PHYS 301 or MATH 305 or concurrent enrollment, PHYS 205A, and PHYS 205B with grade of C or better.

PHYS320 - Electricity & Magnetism I 320-3 Electricity and Magnetism I. The theory of electric and magnetic fields; electrostatic fields in vacuum and in material media, special methods for the solution of electrostatics problems, energy, and force relations in electrostatic fields; stationary electric fields in conducting media, electric currents, magnetic fields, magnetic properties of matter. Prerequisite: PHYS 301 or MATH 305 or concurrent enrollment, and PHYS 205A,B and MATH 251 with grade of C or better.

PHYS328 - Light 328-2 Light. Light propagation, reflection, refraction, interference, diffraction, polarization, and optical instruments. Prerequisite: PHYS 203B or 205B with grade of C or better.
PHYS345 - Thermodynamics/Stats Phys 345-3 Thermodynamics and Statistical Physics. Thermal behavior of macroscopic matter, the laws of thermodynamics; basis for thermodynamics in statistical mechanics; basic methods and applications of classical and quantum statistical mechanics. Elementary kinetic theory of matter. Prerequisite: PHYS 301, MATH 251 with grade of C or better.

PHYS355 - Modern Physics Lab 355-1 Modern Physics Laboratory. A laboratory class which meets for a two hour session once a week. The laboratory experiments include several of the seminal experimental discoveries that helped establish quantum theory (spectral lines, the charge to mass ratio for the electron, the photoelectric effect, the Franck-Hertz experiment, radioactivity, superconductivity, etc.). Prerequisites: PHYS 205A and PHYS 205B or PHYS 203A and PHYS 203B with a grade of C or better. Lab fee: $25.

PHYS390 - Undergraduate Research 390-1 to 4 Undergraduate Research. An introduction to investigations in physics. Individual work under the supervision of a physics faculty member on a special topic in physics. Not for graduate credit. Special approval needed from the instructor.

PHYS420 - Electricity and Magnetism II 420-3 Electricity and Magnetism II. Induced electromotive force, quasisteady currents and fields, Maxwell's equations, electromagnetic waves and radiation, with applications. Prerequisite: PHYS 320 with grade of C or better.

PHYS424 - Electronics 424-4 Electronics for Scientists. Coordinated two-hour lecture and four-hour laboratory study of electronics. Emphasis is on overall modern electronics and its applications in the experimental research laboratory setting. Topics include DC and AC circuit theory, measurement techniques, semiconductor active devices, operational amplifiers and feedback, digital circuits, Boolean algebra, microprocessors and large scale integration, digital to analog/analog to digital conversion, and data acquisition. Prerequisite: PHYS 203B or 205B and MATH 111 with a grade of C or better.

PHYS425 - Solid State Physics 425-3 Solid State Physics I. Structure of a crystalline solid; lattice vibrations and thermal properties; electrons in metals; band theory; electrons and holes in semiconductors; opto-electronic phenomena in solids; dielectric and magnetic properties; superconductivity. Prerequisite: PHYS 310, 320, and 430 with grade of C or better.

PHYS428 - Modern Optics and Lasers 428-3 Modern Optics and Lasers. Properties of electromagnetic waves in space and media, polarization and interference phenomena and devices, electro- and magneto-optic effects, optical gain, and lasers. Prerequisite: PHYS 420 with grade of C or better.

PHYS430 - Quantum Mechanics I 430-3 Quantum Mechanics I. An introduction to quantum phenomena, wells, barriers, Hydrogenic atoms, angular momentum and identical particles. Prerequisite: PHYS 305, 310, and 320 with a grade of C or better. Prior or concurrent enrollment in PHYS 420 is desirable.

PHYS431 - Atomic Physics 431-3 Atomic and Molecular Physics I. Atomic spectra and structure; molecular spectra and structure. Prerequisite: PHYS 430 with a grade of C or better.

PHYS432 - Nuclear Physics 432-3 Nuclear Physics I. Basic nuclear properties and structure; radioactivity, nuclear excitation, and reactions, nuclear forces; fission and fusion. Prerequisite: PHYS 430 with grade of C or better.

PHYS440 - Quantum Mechanics II 440-3 Applications of Quantum Mechanics. Applications of quantum mechanics to include time-independent and time-dependent perturbation theory, variational methods, introduction to solid-state physics and materials. Prerequisite: PHYS 430 with grade of C or better.

PHYS445 - Thermodynamics/Stat Mech 445-3 Thermodynamics and Statistical Mechanics. Laws of thermodynamics; Principles and Applications of Classical and Quantum Statistical Mechanics; Introduction to Phase Transitions. Prerequisites: PHYS 305 and PHYS 301 both with a grade of C or better; MATH 251 with a grade of C or better.

PHYS450 - Advanced Lab 450-3 Advanced Laboratory Techniques. Introduces students to experimental research and encourages them to develop and carry out experiments. Prerequisite: PHYS 305 and PHYS 355 with a grade of C or better. Lab fee: $50.

PHYS458 - Laser and Optics Lab 458-2 Laser and Optical Physics Laboratory. Properties of laser beams and resonators, fluorescence and two photon spectroscopy, diffraction, Fourier transformation and
frequency filtering, electro- and magneto-optic modulation, fiber propagation and related experiments. Prerequisite: PHYS 428 with grade of C or better.

**PHYS470 - Special Projects** 470-1 to 3 Special Projects. Each student chooses or is assigned a definite investigative project or topic. Prerequisite: PHYS 310, 320 or consent of instructor.

**PHYS475 - Special Topics** 475-3 Special Topics in Physics. These courses are advanced special topics in physics designed to enable undergraduate and graduate students to become well-versed in a particular and current research area of physics with the intention of preparing them for future research and/or industrial applications. They are offered as the need arises and interest and time permit. Students are required to give presentations. Special approval needed from the instructor.

**PHYS476B - Biological Physics** 476B-3 Introduction to Biological Physics. This course provides an introduction to how physics principles and techniques are applied to study and describe complex and emergent processes found at the biological and biomolecular level. This course combines several topics not usually covered in standard undergraduate science courses to qualify and quantify cell structure, mechanics, dynamics, self-assembly, and biological functionality. Prerequisites: Two semesters of an introductory physics sequence (PHYS 203A,B or PHYS 205A,B) with minimum grades of C, MATH 150 or concurrent enrollment.

**PHYS476C - Computational Physics** 476C-3 Introduction to Computational Physics. This course provides foundational knowledge in the usage of computers for solving natural problems in different types of physical systems. The class will give a thorough understanding of various numerical techniques such as interpolating/extrapolating data, integrating ordinary and partial differential equations, and solving linear algebra problems. Students will be guided to write programs for solving several applied physics problems in classical and modern physics. A brief survey of High Performance Computing will also be presented giving students a working knowledge of scientific computing. Prerequisites: Two semesters of an introductory physics sequence (PHYS 203A,B or PHYS 205A,B), with minimum grades of C and concurrent enrollment in PHYS 305. PHYS 301, PHYS 310 and PHYS 320 are not required but recommended.

**PHYS476M - Materials Physics** 476M-3 Introduction to Materials Science and NanoPhysics. This course will serve as an introductory course in Materials Science and Nanoscale Physics. Topics to be covered include: The need for studying Materials Science, classification of materials, advanced concepts in materials manufacturing, modern materials, nanoscale materials, electrical, thermal, magnetic and optical properties of materials, tailoring materials for application development, Techniques of Materials characterization, Nanomaterials and Nanotechnology, and Societal Impact. Prerequisites: Two semesters of an introductory physics sequence (PHYS 203A,B or PHYS 205A,B), with minimum grades of C and concurrent enrollment.

**PHYS476Q - Quantum Entanglement** 476Q-3 Quantum Entanglement. This course provides an introduction to the theory of quantum entanglement and its use in quantum information science, especially for the task of communication. Topics include quantum teleportation, entanglement measures, and nonlocality. Prerequisite: MATH 221 with a grade of C or better.

**PHYS490 - Advanced Undergrad Research** 490-1 to 4 Advanced Undergraduate Research. Advanced undergraduate research under the supervision of a physics faculty member. A presentation of the results will be made at the end of the term. Not for graduate credit. Prerequisite: PHYS 310, 320 or consent of instructor and undergraduate advisor.

**Physics Faculty**

**Ali, Naushad**, Professor and Chair, Ph.D., University of Alberta, 1984.

**Byrd, Mark**, Professor, University of Texas, Austin, 1999.

**Chitambar, Eric**, Associate Professor, Ph.D., University of Michigan, Ann Arbor, 2010.

**Cutnell, John D.**, Professor, Emeritus, Ph.D., University of Wisconsin, 1967.

**Gruber, Bruno J.**, Professor, Emeritus, Ph.D., University of Vienna, Austria, 1962.

**Henneberger, Walter C.**, Professor, Emeritus, Ph.D., Gottingen University, Germany, 1959.

**Jayasekera, Thushari**, Assistant Professor, Ph.D., University of Oklahoma, Norman, 1999.
Johnson, Kenneth W., Professor, Emeritus, Ph.D., Ohio State University, 1967.
Malik, F. Bary, Professor, Emeritus, Ph.D., Gottingen University, West Germany, 1958.
Masden, J. Thomas, Associate Professor, Emeritus, Ph.D., Purdue University, 1983.
Mazumdar, Dipanjan, Assistant Professor, Ph.D., Brown University, 2008.
Migone, Aldo, Professor, Emeritus, Ph.D., Pennsylvania State University, 1984.
Sanders, Frank C., Associate Professor, Emeritus, Ph.D., University of Texas, 1968.
Saporoschenko, Mykola, Professor, Emeritus, Ph.D., Washington University, 1958.
Silbert, Leonardo, Associate Professor, Ph.D., University of Cambridge, England, 1998.
Talapatra, Saikat, Professor, Ph.D., Southern Illinois University, 2002.

Last updated: 02/10/2017

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Catalog Year Statement:
Students starting their collegiate training during the period of time covered by this catalog (see bottom of this page) are subject to the curricular requirements as specified herein. The requirements herein will extend for a seven calendar-year period from the date of entry for baccalaureate programs and three years for associate programs. Should the University change the course requirements contained herein subsequently, students are assured that necessary adjustments will be made so that no additional time is required of them.