Undergraduate Catalog 2017–18

Department of Physics

College of Natural Sciences and Mathematics

www.iup.edu/physics

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Indiana University of Pennsylvania

Department of Physics

Website: *www.iup.edu/physics*
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The goal of the Department of Physics is to prepare students for productive careers in physics. Two degree programs are offered: bachelor of science degree program in physics and bachelor of science in education degree program in physics education. The BS—Physics offers preparation for graduate study in physics or for research in industrial technology. There are three tracks in the BS—Physics program: Nanomaufacturing Technology, Pre-engineering, and Applied Physics.

Bachelor of Science

Students in the **BS—Physics/Nanomanufacturing Technology Track (NMT)** take one semester of experiential learning in the high-tech field of semiconductor device manufacturing at the state-of-the-art facility at Penn State—University Park Campus. Students must earn a GPA of at least 3.0 in the required science and mathematics courses to be considered for admission into the capstone semester at Penn State. Graduates of the BS—Physics/NMT may enter careers in industry and education.

The **BS—Physics/Pre-engineering Track** is designed to prepare students for admission to engineering school. The student transfers to the affiliated engineering school after appropriate IUP course work has been completed. When sufficient credit from the affiliated engineering school has been earned, the student transfers the credit back to IUP to earn the bachelor of science degree.

The **BS—Physics/Applied Physics Track** is a practical degree in which the graduates will be trained to work in the semiconductor or electronics industry.

Bachelor of Science in Education

The **BSEd—Physics Education** combines the content knowledge of physics with the pedagogical training offered by the College of Education and Communications to prepare graduates to teach physics as well as science in the secondary school.

Minor in Physics

To minor in physics, a student must successfully complete 18-20 credits in physics consisting of at least 6 credits at the 300 level or higher.

Nanofabrication Cooperative Experience

The IUP physics department participates in a cooperative agreement with Penn State University (PSU) to help address the need of Pennsylvania industry for skilled nanofabrication workers. anyone who meets the prereq-uisite requirements may enroll through IUP in a one-semester experience at the PSU Center for Nanotechnology Education and Utilization (CNEU). These courses are offered in two modes: (1) as a capstone semester expereince at the Penn State CNEU or (2) as a hybrid capstone semester consisting of distance learning followed by a two-week hands-on lab experience at CNEU. For more information, contact the physics department.

Bachelor of Science—Physics

Liberal Studies: As outlined in Liberal Studies section with the following specifications:		44
Mathematics: MATH 125		
Natural Science: PHYS 131-141 and 132-142		
Liberal Studies Elective: 3cr, MATH 126, no courses with PHYS prefix		
Major:		34
Required Courses:		
PHYS 131	Physics I-C Lecture (1)	*cr
PHYS 132	Physics II-C Lecture (1)	*cr
PHYS 141	Physics I-C Lab (1)	*cr
PHYS 142	Physics II-C Lab (1)	*cr
PHYS 331	Modern Physics	3cr
PHYS 345	Optics	3cr
PHYS 441	Classical Mechanics	3cr
PHYS 451	Electricity and Magnetism	3cr
Additional Required Courses:		
PHYS 231	Electronics	4cr
PHYS 342	Thermal and Statistical Physics	3cr
PHYS 350	Intermediate Experimental Physics I	3cr
PHYS 401	Theoretical Physics	3cr
PHYS 461	Quantum Mechanics I	3cr
One course from the following: PHYS 472 or 490		3cr
One additional PHYS majors course		3cr
Other Requirements:		16-22
COSC 110	Problem Solving and Structured Programming	3cr
MATH 225	Calculus III	3cr
MATH 341	Differential Equations	3cr
MATH 342	Advanced Mathematics for Applications	4cr
One course from the following:		
COSC 250, MATH 171, 363, 421, 423		3cr
Foreign Language Intermediate Level (2)		0-6cr
Free Electives:		20-26
Total Degree Requirements:		120

(1) Credits are counted in the Liberal Studies natural science requirement.
(2) Six credits of computer programming will substitute for the foreign language requirement: COSC 110, 210, or higher-level computer science courses (COSC 250 recommended), with department permission.

Bachelor of Science—Physics/Pre-engineering Track

Liberal Studies: As outlined in Liberal Studies section with the following specifications: 44
Mathematics: MATH 125
Natural Science: PHYS 131-141 and 132-142
Liberal Studies Elective: 3cr, MATH 126, no courses with PHYS prefix

Major:		34
Required Courses:		
PHYS 131	Physics I-C Lecture (1)	*cr
PHYS 132	Physics II-C Lecture (1)	*cr
PHYS 141	Physics I-C Lab (1)	*cr
PHYS 142	Physics II-C Lab (1)	*cr
PHYS 331	Modern Physics	3cr
PHYS 345	Optics	3cr
PHYS 441	Classical Mechanics	3cr
PHYS 451	Electricity and Magnetism	3cr
Additional Required Physics Courses: (2)		
PHYS 231	Electronics	4cr
PHYS 342	Thermal and Statistical Physics	3cr
PHYS 350	Intermediate Experimental Physics I	3cr
PHYS 355	Computer Interfacing	3cr
PHYS 401	Theoretical Physics	3cr
PHYS 461	Quantum Mechanics I	3cr
PHYS 472	Nuclear Physics ***or***	
or 490	Solid State Physics	3cr

Controlled Electives: As required per engineering program		6-8
Chemical Engineering:		
CHEM 231	Organic Chemistry I	4cr
CHEM 232	Organic Chemistry II	4cr
Civil Engineering:		
MATH 216	Probability and Statistics for Natural Sciences	3cr
——	Technical elective	3-4cr
Electrical Engineering:		
MATH 216	Probability and Statistics for Natural Sciences	3cr
——	Technical elective	3-4cr
Industrial Engineering:		
MATH 216	Probability and Statistics for Natural Sciences	3cr
——	Technical elective	3-4cr
Materials Science and Engineering:		
CHEM 231	Organic Chemistry I	4cr
CHEM 232	Organic Chemistry II	4cr
Mechanical Engineering:		
——	Technical electives	6-8cr

Other Requirements:		24-30
CHEM 111	General Chemistry I	4cr
CHEM 112	General Chemistry II	4cr
COSC 110	Problem Solving and Structured Programming	3cr
COSC 250	Introduction to Numerical Methods	3cr
MATH 225	Calculus III	3cr
MATH 341	Differential Equations	3cr
MATH 342	Advanced Mathematics for Applications	4cr
Foreign Language Intermediate Level (3)		0-6cr

Free Electives: (If no automatic transfer into the University of Pittsburgh) 4-12

Special Requirements:
Two years at University of Pittsburgh School of Engineering (4)

Total Degree Requirements: 120

(1) Credits are counted in the Liberal Studies natural science requirement.
(2) Some of these courses may be taken at the University of Pittsburgh.
(3) Six credits of computer programming will substitute for the foreign language requirement: COSC 110, 210, or higher-level computer science courses (COSC 250 recommended), with department permission.
(4) A 3.0 cumulative GPA is required for transfer to the University of Pittsburgh. Students transferring to University of Pittsburgh do not need a second writing-intensive class. Students need at most 64 additional credits from the University of Pittsburgh to receive the engineering degree.
(#) See advisory paragraph "Timely Completion of Degree Requirements" in the section on Requirements for Graduation. Students earn two degrees, hence the high credit count.

Bachelor of Science—Physics/Nanomanufacturing Technology Track

Liberal Studies: As outlined in Liberal Studies section with the following specifications: 44
Mathematics: MATH 125
Natural Science: PHYS 131-141 and 132-142
Liberal Studies Elective: 3cr, MATH 126, no courses with PHYS prefix

Major:		46
Required Courses:		
PHYS 131	Physics I-C Lecture	*cr (1)
PHYS 132	Physics II-C Lecture	*cr (1)
PHYS 141	Physics I-C Lab	*cr (1)
PHYS 142	Physics II-C Lab	*cr (1)
PHYS 331	Modern Physics	3cr
PHYS 345	Optics	3cr
PHYS 441	Classical Mechanics	3cr
PHYS 451	Electricity and Magnetism	3cr
Required PSU Capstone Courses:		
NMTT 311	Materials, Safety, and Equipment Overview for Nanofabrication	3cr
NMTT 312	Basic Nanofabrication Process	3cr
NMTT 313	Thin Films in Nanofabrication	3cr
NMTT 314	Lithography and Patterning Techniques	3cr
NMTT 315	Materials Modification in Nanofabrication	3cr
NMTT 316	Characterization, Packaging, and Testing of Nanofabrication Structures	3cr
Additional Required Courses:		
PHYS 231	Electronics	4cr
PHYS 350	Intermediate Experimental Physics I	3cr
PHYS 355	Computer Interfacing	3cr
PHYS 475	Physics of Semiconductor Devices I	3cr
PHYS 476	Physics of Semiconductor Devices II	3cr

Other Requirements:		17-23
CHEM 111	General Chemistry I	4cr
CHEM 112	General Chemistry II	4cr
COSC 110	Problem Solving and Structured Programming	3cr
COSC 250	Introduction to Numerical Methods	3cr
Foreign Language Intermediate Level (2)		0-6cr

Free Electives: 7-13

Total Degree Requirements: 120

(1) Credits are counted in the Liberal Studies natural science requirement.
(2) Six credits of computer programming will substitute for the foreign language requirement: COSC 110, 210, or higher-level computer science courses (COSC 250 recommended), with department permission.

Bachelor of Science—Physics/Applied Physics

Liberal Studies: As outlined in Liberal Studies section with the following specifications: 44
Mathematics: MATH 125
Natural Science: PHYS 131-141 and 132-142
Liberal Studies Elective: 3cr, MATH 126, no courses with PHYS prefix

Major:		28
Required Courses:		
PHYS 131	Physics I-C Lecture	*cr (1)
PHYS 132	Physics II-C Lecture	*cr (1)
PHYS 141	Physics I-C Lab	*cr (1)

PHYS 142	Physics II-C Lab	*cr (1)
PHYS 331	Modern Physics	3cr
PHYS 345	Optics	3cr
PHYS 441	Classical Mechanics	3cr
PHYS 451	Electricity and Magnetism	3cr
Additional Required Courses:		
PHYS 231	Electronics	4cr
PHYS 342	Thermal and Statistical Physics	3cr
PHYS 350	Intermediate Experimental Physics I	3cr
PHYS 475	Physics of Semiconductor Devices I	3cr

Controlled Electives: Select one of the following subfields: 19-21

Solid State Electronics: COSC 300, MATH 342, PHYS 323, 342, 353, 432, 475 21cr

Computer Science: COSC 300, 410, 450, MATH 171, PHYS 342, 353, 432 21cr

Chemistry: CHEM 231, 323, 341, 342, 343, MATH 225 19cr

Biology: BIOL 111, 112, CHEM 231, 351; one course from BIOL 250, 263, 401 19cr

Geoscience: GEOS 201, 202, 203, 341, 342, 371 21cr

Other Requirements: 17-23

CHEM 111	General Chemistry I	4cr
CHEM 112	General Chemistry II	4cr
COSC 110	Problem Solving and Structured Programming	3cr
COSC 250	Introduction to Numerical Methods	3cr
MATH 341	Differential Equations	3cr
Foreign Language Intermediate Level (2)		0-6cr

Free Electives: 4-12

Total Degree Requirements: 120

(1) Credits are counted in the Liberal Studies natural science requirement.

(2) Six credits of computer programming will substitute for the foreign language requirement: COSC 110, 210, or higher-level computer science courses (COSC 250 recommended), with department permission.

Bachelor of Science in Education—Physics (*)

Liberal Studies: As outlined in Liberal Studies section with the following specifications: 47

Mathematics: MATH 125
Natural Science: CHEM 111-112 or CHEM 113-114
Social Science: PSYC 101
Liberal Studies Electives: 6cr, MATH 341, GEOS 101 or 103 or 105, no courses with PHYS prefix

College: 31

Preprofessional Education Sequence:

ACE 103	Digital Instructional Technology	3cr
EDSP 102	Educational Psychology	3cr
Professional Education Sequence:		
EDEX 301	Education of Students with Disabilities in Inclusive Secondary Settings	2cr
EDEX 323	Instruction of English Language Learners with Special Needs	2cr
EDSP 477	Assessment of Student Learning: Design and Interpretation of Educational Measures	3cr
EDUC 242	Pre-student Teaching Clinical Experience I	1cr
EDUC 342	Pre-student Teaching Clinical Experience II	1cr
EDUC 441	Student Teaching	12cr
EDUC 442	School Law	1cr
EDUC 451	Teaching Science in the Secondary School	3cr

Major: 33

Required Courses:

PHYS 131	Physics I-C Lecture	3cr
PHYS 132	Physics II-C Lecture	3cr
PHYS 141	Physics I-C Lab	1cr
PHYS 142	Physics II-C Lab	1cr
PHYS 231	Electronics	4cr
PHYS 331	Modern Physics	3cr
PHYS 345	Optics ***or***	
or 342	Thermal and Statistical Physics	3cr
PHYS 350	Intermediate Experimental Physics I	3cr
PHYS 441	Classical Mechanics	3cr
PHYS 451	Electricity and Magnetism	3cr
Controlled Elective:		
Physics electives—two major courses 200 level or higher		6cr

Other Requirements: 10

BIOL 201 ***or***	Principles of Ecology and Evolution ***or***	
or 202	Principles of Cell and Molecular Biology	4cr
MATH 126	Calculus II for Physics, Chemistry, and Mathematics	3cr
MATH 225	Calculus III for Physics, Chemistry, and Mathematics	3cr

(#) **Total Degree Requirements:** 121

(*) See requirements leading to teacher certification, titled "3-Step Process for Teacher Education," in the College of Education and Communications section of this catalog.

(#) See advisory paragraph "Timely Completion of Degree Requirements" in the section on Requirements for Graduation.

Minor—Physics 18-20

Required Courses: 8

PHYS 131 ***or*** 111	Physics I-C Lecture ***or*** Physics I Lecture	3cr
PHYS 141 ***or*** 121	Physics I-C Lab ***or*** Physics I Lab	1cr
PHYS 132 ***or*** 112	Physics II-C Lecture ***or*** Physics II Lecture	3cr
PHYS 142 ***or*** 122	Physics II-C Lab ***or*** Physics II Lab	1cr

Additional Elective Courses: 12

At least 10 credits from the following, 6cr of which must be at 300 level or higher: (1)
PHYS 231, 331, 342, 355

(1) Other courses may be considered with department recommendation.