

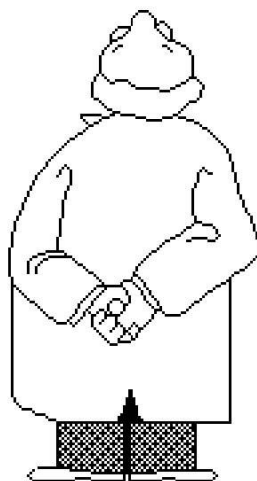


**University at Buffalo**  
*State University of New York*

# Undergraduate Handbook

## Department of Physics

2016-2017

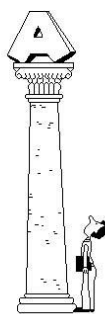


Department of Physics  
239 Fronczak Hall  
Buffalo, NY 14260-1500  
(716) 645-2007, FAX: (716) 645-2507  
<http://www.physics.buffalo.edu>

Undergraduate Director  
Professor John Cerne  
1289 Fronczak Hall  
(716) 645-2542  
e-mail: [jcerne@buffalo.edu](mailto:jcerne@buffalo.edu)

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## I. GENERAL INFORMATION

**Physics is the fundamental science** underlying all natural phenomena. Its elegant experiments and fundamental theories have provided much of the advancements in present day science and technology. From the smallest sub-atomic particles to the vastness of cosmic expansion, and at intermediate scales – in solid-state electronics, magnetism, superconductivity, biological function, and geologic events – physics profoundly impacts our understanding of nature and our ability to harness its secrets for the progress of human kind.

**The central mission** of the undergraduate program in the Department of Physics is to provide students with an outstanding educational experience consisting of comprehensive and rigorous coursework and laboratory training leading to a baccalaureate degree. The core of our major programs involves courses focused on five key topic-areas – classical mechanics, electricity and magnetism, thermal and statistical physics, modern physics including quantum mechanics and relativity, and experimental methods. In addition, our upper-level electives, research courses, and internships allow students to experience an array of specialty areas in further preparation for graduate study and future careers. Within the subjects of the curriculum, student learning is assessed in 5 general program outcome categories: basic laws of physics, critical thinking and problem solving skills, laboratory skills, contemporary areas of physics, and written and oral communication skills. As part of the overall mission of the College of Arts and Sciences, the Department also provides physics education to students majoring in other sciences, in engineering and professional programs, and to non-science majors. The Department actively advises prospective and current students on educational choices and career paths. Our faculty is vigorously engaged in research at the frontiers of physics, and is committed to excellence in teaching and mentoring at all levels of the educational program.

The Department of Physics is housed in Fronczak Hall and consists of 27 full-time faculty members, an administrative assistant, four secretaries, and a technical staff. For detailed information on the Department follow the links on the Department's home page at [www.physics.buffalo.edu](http://www.physics.buffalo.edu).

The Department of Physics offers a *B.S.*, *B.A.*, and a *Minor in Physics*; and participates in the interdisciplinary programs which lead to a *B.A. in Physics with Teaching of Science Concentration*, a *B.S. in Computational Physics*, a *B.S. in Mathematical Physics*, and a *B.S. in Engineering Physics*. There is also a 5 year program leading to a *B.S. in Computational Physics/M.S. in Physics*. The required courses and the recommended sequence for each program are given in Section III. The *General Education* requirements that apply to the various programs are summarized in Section IV, while general guidelines for all the programs are presented in Section V.

It is necessary to apply for acceptance into any of the above programs. The acceptance criteria for students who have completed the relevant course work at U.B. are given in Section III under the heading for each program. In general, it is possible to apply for any of the programs in the first

semester of the sophomore year. The procedure for applying to each program is given in Sect. VI.

The Department of Physics *Honors Program* and the option of doing a *Senior Thesis* are described in Sect. VII. Advice for students planning to do graduate work in Physics is given in Section IX.

For general information about the programs in Physics it is best to consult with the Undergraduate Director for Physics, Professor John Cerne, 128 Fronczak Hall, 716-645-2542, e-mail: [jcerne@buffalo.edu](mailto:jcerne@buffalo.edu).

Physics majors, as well as students who intend to become physics majors, should discuss their program of study with the Undergraduate Director before registering for each semester. This is to ensure that the proper courses are being taken, and in a reasonable sequence. Students who have signed up for the Finish in Four plan are required to make an appointment to meet with their advisor during the first 3 weeks of each semester. When a student is close to graduation he or she should consult with the Undergraduate Director to make sure that all of the requirements of the Department of Physics, as well as the General Education requirements, will have been met by the proposed date of graduation. In order to graduate a student must apply for graduation in their HUB Student Center via <https://myub.buffalo.edu>. Applications for June 1, September 1, and February 1 graduations must be filed by February 15, June 15, and September 15, respectively.

## II. DEGREE PROGRAMS IN PHYSICS

Before selecting a degree program in physics, the student should study the specific requirements carefully and discuss them with the Undergraduate Director (Prof. Cerne). The procedure for applying to each program is given in Section VI.

*The B.S. in Physics* is designed for undergraduates considering professional careers as a physicist. It is strongly recommended for students planning to pursue physics Ph.D. or M.S. degrees, and careers in research and development in academia, industry, or government laboratories that focus primarily on research, advanced development, or higher education in physics.

*The B.A. in Physics* is designed for students who are interested in physics, but wish to have a broader education in their undergraduate years. Students who complete this program will have enough background to go on to graduate school in physics, but the program is more appropriate for students who desire a working knowledge of basic physics in order to pursue allied careers in such areas as geophysics, biophysics, science and public policy, to name a few possibilities.

*The Minor in Physics* provides a good secondary area of concentration for all students in science and engineering, as well as students in such areas as philosophy, history, or the arts.

*The B.A. in Physics with Teaching of Science Concentrations* provides the background in physics and mathematics needed for teaching physics at the high school level. It is not meant for students who wish to do graduate work in physics, but it is appropriate for graduate study in education.

The *B.S. degrees in Mathematical Physics, Engineering Physics, and Computational Physics* are interdisciplinary programs that combine requirements from two major degree programs. The *Mathematical Physics* program is overseen by the Department of Physics and co-administered by the Department of Mathematics. It is designed for students who wish to pursue graduate degrees in theoretical physics or applied mathematics and careers in these areas.

The *Engineering Physics* program is overseen by the Department of Electrical Engineering and co-administered by the Department of Physics. It is designed for students whose interests center on the more fundamental aspects of engineering, or on allied areas of physics applications. It is an appropriate course of study for students whose career objectives are in applied physics, physical electronics, solid state electronics, electrical metrology, laser physics, advanced materials, and related fields. The program is such that students can pursue a graduate degree in Electrical Engineering or Applied Physics.

The *B.S. in Computational Physics* combines requirements from the *B.S. in Physics* and the *B.S. in Computer Science*. It is overseen by the Department of Physics and designed for students who are interested in applying advanced computer based techniques to physics research, or who wish to develop technical software. The program is such that students can pursue a graduate degree in either physics or computer science. It is also possible to pursue a 5-year program leading to the degree, *B.S in Computational Physics/M.S. in Physics*.

### III. COURSE REQUIREMENTS, ACCEPTANCE CRITERIA, AND RECOMMENDED SEQUENCES

For all of the programs described in this section students must also fulfill the requirements of the General Education Program, which are summarized in Section IV. See Appendix B for course offering and description information or force registration information. See the University at Buffalo's Undergraduate Degree & Course Catalog website for the Official Grading and Repeat Policy here: [undergrad-catalog.buffalo.edu/policies/grading/repeat.html](http://undergrad-catalog.buffalo.edu/policies/grading/repeat.html)

PHY 101 has been designated as a controlled enrollment course. The Department usually permits repeat enrollment in this course during summer or winter session only.

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#### PHYSICS-B.S.

**Acceptance Criteria:** GPA of 2.0 in MTH 141-142, PHY 107-108/158

#### REQUIRED COURSES

CHE 101 General Chemistry

CHE 102 General Chemistry

MTH 141 College Calculus I

MTH 142 College Calculus II

MTH 241 College Calculus III

MTH 306 Introduction to Differential Equations

MTH 417 Survey of Multivariable Calculus

MTH 418 Survey of Partial Differential Equations

PHY 107 General Physics I or PHY117 Honors Physics I

PHY 108 General Physics II or PHY118 Honors Physics II

PHY 158 General Physics II Lab

PHY 207 General Physics III or PHY217 Honors Physics III

PHY 208 General Physics IV

PHY 257 General Physics III Lab

PHY 301 Intermediate Mechanics I

PHY 302 Intermediate Mechanics II

PHY 307 Modern Physics Lab

PHY 401 Quantum Mechanics I-fundamentals

PHY 402 Quantum Mechanics II-applications

PHY 403 Electricity and Magnetism I

PHY 404 Electricity and Magnetism II

PHY 405 Thermal and Statistical Physics I

PHY 407 Advanced Laboratory or PHY 408 Advanced Laboratory

Two PHY electives (from: PHY 406 Thermal and Statistical Physics II, PHY 425 Intermediate Optics, PHY 410 Computational Physics I, PHY 412 Nuclear and Particle Physics, PHY 413 Electronics, PHY 431 Intro. to Math Physics I, or PHY 434 Solid State Physics )

One additional 3-credit technical elective course in physics, another science, engineering, or mathematics at or above the 300-level, as approved by the Physics Undergraduate Director.

## RECOMMENDED SEQUENCE FOR BS IN PHYSICS MAJOR REQUIREMENTS

### First Year

Fall	Spring
CHE 101 General Chemistry	CHE 102 General Chemistry
MTH 141 College Calculus I	MTH 142 College Calculus II
PHY 107 General Physics I <b>or</b> PHY 117 Honors Physics I (preferred)	PHY 108 General Physics II <b>or</b> PHY 118 Honors Physics II (preferred)
ENG 101 (or 201*)	PHY 158 General Physics II Lab
Library Skills	ENG 201 (or Humanities Gen Ed*)

### Second Year

MTH 241 College Calculus III	PHY 207 General Physics III <b>or</b> PHY 217 Honors Physics III
MTH 306 Intro to Differential Equations	PHY 257 General Physics III Lab
PHY 208 General Physics IV	MTH 418 Survey of Partial Differential Eqns
UGC 111	UGC 112
Language 1	Language 2

### Third Year

PHY 301 Intermediate Mechanics I	PHY 302 Intermediate Mechanics II
PHY 401 Quantum Mechanics I	PHY 307 Modern Physics Lab
MTH 417 Survey of Multivariable Calculus	PHY 402 Quantum Mechanics II
UGC 211 (or American Pluralism)	Arts Gen Ed
	Social Science

### Fourth Year

PHY 403 Electricity and Magnetism I	PHY 404 Electricity and Magnetism II
PHY 405 Thermal and Statistical Physics I	PHY Elective
PHY elective	Technical elective (F or Sp)
PHY 407 Advanced Laboratory (F) <b>or</b> PHY 408 Advanced Laboratory (Sp)	

\*Students placed into ENG 101 should take ENG 101 in the fall and ENG 201 in the spring. Students placed in ENG 201 should take ENG 201 in the fall and a Humanities Gen Ed in the spring.

### **SUMMARY of Credit Hours**

Total required credit hours in physics	51
Total required credit hours outside physics	34
General education courses and electives	35
Total required credit hours	120

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## PHYSICS–B.A.

**Acceptance Criteria:** GPA of 2.0 in MTH 141–142, PHY 107–108/158

### REQUIRED COURSES

CHE 101 General Chemistry  
 CHE 102 General Chemistry  
 MTH 141 College Calculus I  
 MTH 142 College Calculus II  
 MTH 241 College Calculus III  
 MTH 306 Introduction to Differential Equations  
 PHY 107 General Physics I or PHY 117 Honors Physics I  
 PHY 108 General Physics II or PHY 118 Honors Physics II  
 PHY 158 General Physics II Lab  
 PHY 207 General Physics III or PHY 217 Honors Physics III  
 PHY 208 General Physics IV  
 PHY 257 General Physics III Lab  
 PHY 301 Intermediate Mechanics I  
 PHY 307 Modern Physics Lab  
 PHY 401 Quantum Mechanics I-fundamentals  
 PHY 402 Quantum Mechanics II-applications  
 PHY 403 Electricity and Magnetism I  
 PHY 405 Thermal and Statistical Physics I  
 PHY 407 Advanced Laboratory **or** PHY 408 Advanced Laboratory

Two PHY electives (Choose from: PHY 302 Intermediate Mechanics II, PHY 404 Electricity and Magnetism II, PHY 406 Thermal and Statistical Physics II, PHY 410 Computational Physics I, PHY 413 Electronics, PHY 425 Intermediate Optics, or PHY 431 Intro. to Math Physics I.)

One additional 300/400-level PHY course excluding PHY 499

### RECOMMENDED SEQUENCE FOR BA IN PHYSICS MAJOR REQUIREMENTS

#### First Year

Fall	Spring
CHE 101 General Chemistry	CHE 102 General Chemistry
MTH 141 College Calculus I	MTH 142 College Calculus II
PHY 107 General Physics I <b>or</b> PHY 117 Honors Physics I (preferred)	PHY 108 General Physics II <b>or</b> PHY 118 Honors Physics II (preferred)
ENG 101 or ENG 201*	PHY 158 General Physics II Lab
Library Skills	ENG 201 or Humanities*

### Second Year

MTH 241 College Calculus III	PHY 207 General Physics III <b>or</b> PHY 217 Honors Physics III
MTH 306 Intro to Differential Equations	PHY 257 General Physics III Lab
PHY 208 General Physics IV	UGC 112
UGC 111	Language 2
Language 1	

### Third Year

PHY 301 Intermediate Mechanics I	PHY Elective (F or Sp)
PHY 401 Quantum Mechanics I	PHY 307 Modern Physics Lab
UGC 211 or American Pluralism	PHY 402 Quantum Mechanics II
	Social Science

### Fourth Year

PHY 403 Electricity and Magnetism I	PHY Elective (F or Sp)
PHY 405 Thermal and Statistical Physics I	PHY Elective (F or Sp)
PHY 407 Advanced Laboratory (F) <b>or</b> PHY 408 Advanced Laboratory (Sp)	
Arts Gen Ed	

\*Students placed into ENG 101 should take ENG 101 in the fall and ENG 201 in the spring. Students placed into ENG 201 should take ENG 201 in the fall and a Humanities Gen Ed in the spring.

### SUMMARY of Credit Hours

Total required credit hours in physics	46
Total required credit hours outside physics	26
General education courses and electives	48
Total required credit hours	120

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## PHYSICS - MINOR

**Acceptance Criteria:** GPA of 2.0 in MTH 141-142, PHY 107-108/158

### REQUIRED COURSES

MTH 141 College Calculus I

MTH 142 College Calculus II

PHY 107 General Physics I or PHY 117 Honors Physics I

PHY 108 General Physics II or PHY 118 Honors Physics II

PHY 158 General Physics II Lab

PHY 207 General Physics III or PHY 217 Honors Physics III (lab is not required)

PHY 208 General Physics IV (lab is not required)

PHY 301 Intermediate Mechanics I

PHY 403 Electricity and Magnetism I

One 300/400-level PHY elective course (excluding PHY 499; PHY 401 Modern Physics I is strongly recommended)

### RECOMMENDED SEQUENCE FOR MINOR REQUIREMENTS

#### First Year

Fall	Spring
MTH 141 College Calculus I	MTH 142 College Calculus II
PHY 107 General Physics I <b>or</b> PHY 117 Honors Physics I	PHY 108 General Physics II <b>or</b> PHY 118 Honors Physics II
	PHY 158 General Physics II Lab

#### Second Year

PHY 208 General Physics IV	PHY 207 General Physics III <b>or</b> PHY 217 Honors Physics III
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#### Third Year

PHY 301 Intermediate Mechanics I	
PHY Elective	

#### Fourth Year

PHY 403 Electricity and Magnetism I	
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### SUMMARY of Credit Hours

Total required credit hours in physics	25
Total required credit hours outside physics	8
Total required credit hours	33

## PHYSICS - B.A. WITH TEACHING OF SCIENCE CONCENTRATIONS

Students pursuing this concentration must also pursue the Undergraduate Minor in Education, which is administered by the Department of Learning and Instruction (LAI). Applications to the minor must be filed with the LAI office in 505 Baldy Hall (the application is available online at <http://gse.buffalo.edu/programs/edminor>).

This concentration is designed for the student whose career goal is to teach physics (or physics and chemistry, see below) in grades 7-12. Students interested in this concentration should obtain advisement from the director of undergraduate studies in physics and, for questions related to the education courses, from the LAI office.

Completion of the major concentration (including the required education courses) provides a strong foundation in content knowledge and a head start on education coursework required for an Initial Teacher Certificate to begin teaching in grades 7-12 in New York. In order to receive a University at Buffalo recommendation for the issuance of the Initial Teacher Certificate, a student must successfully complete the graduate-level initial teacher education program within the Graduate School of Education (<http://gse.buffalo.edu/>). It is then possible to complete, within the state-mandated five years, the master's degree required for a Professional Teacher Certificate, provided all New York State requirements have been successfully completed.

**Acceptance Criteria for Physics:** GPA of 2.0 in MTH 141-142, PHY 107-108/158. LAI requires a minimum overall GPA of 2.5 for admission to the minor in education.

### TEACHING OF SCIENCE - PHYSICS

#### REQUIRED COURSES FOR PHYSICS

CHE 101 General Chemistry  
CHE 102 General Chemistry  
MTH 141 College Calculus I  
MTH 142 College Calculus II  
MTH 241 College Calculus III  
MTH 306 Introduction to Differential Equations  
PHY 107 General Physics I or PHY 117 Honors Physics I  
PHY 108 General Physics II or PHY 118 Honors Physics II  
PHY 158 General Physics II Lab  
PHY 207 General Physics III or PHY 217 Honors Physics III  
PHY 208 General Physics IV  
PHY 257 General Physics III Lab  
PHY 307 Modern Physics Lab  
Four 300/400-level PHY electives (excluding PHY 499)

## RECOMMENDED SEQUENCE FOR TEACHING OF SCIENCE MAJOR REQUIREMENTS

### Teaching of Science - Physics

#### First Year

Fall	Spring
CHE 101 General Chemistry	CHE 102 General Chemistry
MTH 141 College Calculus I	MTH 142 College Calculus II
PHY 107 General Physics I <b>or</b> PHY 117 Honors Physics I (preferred)	PHY 108 General Physics II <b>or</b> PHY 118 Honors Physics II
ENG 101 or 201*	PHY 158 General Physics II Lab
	ENG 201 or Humanities Gen Ed*

#### Second Year

MTH 241 College Calculus III	
MTH 306 Intro to Differential Equations	PHY 207 General Physics III <b>or</b> PHY 217 Honors Physics III
PHY 208 General Physics IV	PHY 257 General Physics III Lab
UGC 111	UGC 112
Language 1	Language 2

#### Third Year

PHY Elective	PHY 307 Modern Physics Lab
UGC 211 or American Pluralism	PHY Elective
Arts Gen Ed	Social Science

#### Fourth Year

PHY Elective	PHY Elective
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\*Students placed into ENG 101 should take ENG 101 in the fall and ENG 201 in the spring. Students placed into ENG 201 should take ENG 201 in the fall and a Humanities Gen Ed in the spring.

#### SUMMARY of Credit Hours

Total required credit hours in mathematics, chemistry and physics	57
Total required credit hours in education	19
General education courses and electives	44
Total required credit hours	120

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## TEACHING OF SCIENCE – PHYSICS AND CHEMISTRY

### REQUIRED COURSES

CHE 101 General Chemistry  
CHE 102 General Chemistry  
CHE 201 Organic Chemistry  
CHE 202 Organic Chemistry  
CHE 214 Introduction to Analytical Chemistry  
MTH 141 College Calculus I  
MTH 142 College Calculus II  
MTH 241 College Calculus III  
MTH 306 Introduction to Differential Equations  
PHY 107 General Physics I or PHY 117 Honors Physics I  
PHY 108 General Physics II or PHY 118 Honors Physics II  
PHY 158 General Physics II Lab  
PHY 207 General Physics III or PHY 217 Honors Physics III  
PHY 208 General Physics IV  
PHY 257 General Physics III Lab  
PHY 307 Modern Physics Lab  
Two 300/400-level PHY electives (excluding PHY 499)

### RECOMMENDED SEQUENCE FOR TEACHING OF SCIENCE MAJOR REQUIREMENTS

#### Provisional Certification in Physics and Chemistry

##### First Year

Fall	Spring
CHE 101 General Chemistry	CHE 102 General Chemistry
MTH 141 College Calculus I	MTH 142 College Calculus II
PHY 107 General Physics I <b>or</b> PHY 117 Honors Physics I (preferred)	PHY 108 General Physics II <b>or</b> PHY 118 Honors Physics II (preferred)
ENG 101 or 201*	PHY 158 General Physics II Lab
	ENG 201 or Humanities Gen Ed

##### Second Year

MTH 241 College Calculus III	PHY 207 General Physics III <b>or</b> PHY 217 Honors Physics III
MTH 306 Intro to Differential Equations	PHY 257 General Physics III Lab
PHY 208 General Physics IV	UGC 112

UGC 111	Language 2
Language 1	

### Third Year

CHE 201 Organic Chemistry	CHE 202 Organic Chemistry
CHE 214 Introduction to Analytical Chemistry	PHY 307 Modern Physics Lab
UGC 211 or American Pluralism	Arts Gen Ed
	Social Science

### Fourth Year

PHY Elective	PHY Elective
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\*Students placed into ENG 101 should take ENG 101 in the fall and ENG 201 in the spring. Students placed into ENG 201 should take ENG 201 in the fall and a Humanities Gen Ed in the spring.

### SUMMARY of Credit Hours

Total required credit hours in chemistry, mathematics, and physics	61
Total required credit hours in education	19
General education courses and electives	37
Total required credit hours	120

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## MATHEMATICAL PHYSICS – B.S.

**Acceptance Criteria:** GPA of 2.5 in MTH 141–142, PHY 107–108/158.

### REQUIRED COURSES

MTH 141 College Calculus I  
 MTH 142 College Calculus II  
 MTH 241 College Calculus III  
 MTH 306 Introduction to Differential Equations  
 MTH 309 Introductory Linear Algebra  
 MTH 417 Survey of Multivariable Calculus  
 MTH 418 Survey of Partial Differential Equations  
 MTH 419 Introduction to Abstract Algebra or MTH 420 Advanced Linear Algebra  
 MTH 425 Introduction to Complex Variables I  
 One 300/400-level MTH elective  
 PHY 107 General Physics I or PHY 117 Honors Physics I  
 PHY 108 General Physics II or PHY 118 Honors Physics II  
 PHY 158 General Physics II Lab  
 PHY 207 General Physics III or PHY 217 Honors Physics III  
 PHY 208 General Physics IV  
 PHY 257 General Physics III Lab  
 PHY 301 Intermediate Mechanics I  
 PHY 307 Modern Physics Lab  
 PHY 401 Quantum Mechanics I-fundamentals  
 PHY 403 Electricity and Magnetism I  
 PHY 405 Thermal and Statistical Physics I  
 PHY 407 or PHY 408 Advanced Laboratory  
 PHY 431 Introduction to Mathematical Physics I  
 One PHY elective (one of the following: PHY 302 Intermediate Mechanics II, PHY 402 Quantum Mechanics II, PHY 404 Electricity and Magnetism II, or PHY 406 Thermal and Statistical Physics II)

### RECOMMENDED SEQUENCE FOR BS IN MATHEMATICAL PHYSICS MAJOR REQUIREMENTS

#### First Year

Fall	Spring
MTH 141 College Calculus I	MTH 142 College Calculus II
PHY 107 General Physics I <b>or</b> PHY 117 Honors Physics I (preferred)	PHY 108 General Physics II <b>or</b> PHY 118 Honors Physics II (preferred)
ENG 101 or 201*	PHY 158 General Physics II Lab
Arts Gen Ed	ENG 201 or Humanities*
Library Skills	



### Second Year

MTH 241 College Calculus III	MTH 309 Introductory Linear Algebra
MTH 306 Introduction to Differential Equations	PHY 207 General Physics III <b>or</b> PHY 217 Honors Physics III
PHY 208 General Physics IV	PHY 257 General Physics III Lab
UGC 111	UGC 112
Language 1	Language 2

### Third Year

MTH 417 Survey of Multivariable Calculus	MTH 418 Survey of Partial Differential Eqns.
PHY 301 Intermediate Mechanics I	PHY Elective ( <b>if not taken in 4<sup>th</sup> year</b> )
PHY 401 Quantum Mechanics I	PHY 307 Modern Physics Lab
UGC 211 or American Pluralism	Social Science

### Fourth Year

MTH 419 Introduction to Abstract Algebra	MTH 425 Introduction to Complex Variables I
PHY 431 Intro. To Math. Physics I	MTH Elective
PHY 403 Electricity and Magnetism I	PHY 408 Advanced Laboratory
PHY 405 Thermal and Statistical Physics I	<b>PHY Elective (if not taken in 3<sup>rd</sup> year)</b>

\* Students placed into ENG 101 should take ENG 101 in the fall semester and ENG 201 in the spring semester. Students placed into ENG 201 should take ENG 201 in the fall and a Humanities Gen Ed course in the spring.

#### SUMMARY of Credit Hours

Total required credit hours in mathematics and physics	78
General education courses and electives	42
Total required credit hours	120

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## ENGINEERING PHYSICS-B.S.

**Acceptance Criteria:** In order to be considered for admission, a grade of C or better must be obtained in all technical courses. Students receiving a grade of D or F in any technical course during the first two semesters must repeat the course and receive a grade of C or better to be considered for the program. The technical courses that are required in the first two semesters are: MTH 141-142, PHY 107 (or PHY 117), CHE 107-108, and EAS 140. Application for this program should be made through the *School of Engineering and Applied Sciences* in 410 Bonner Hall (See Sec. VI). Interested students should meet an advisor in the School of Engineering and Applied Sciences, 410 Bonner Hall.

### REQUIRED COURSES

CHE 107 General Chemistry for Engineers  
CHE 108 General Chemistry for Engineers  
EAS 140 Engineering Solutions  
EAS 202 Engineering Impact On Society  
EAS 230 Higher-Level Language  
EE 202 Circuit Analysis I  
EE 310 Electronic Devices and Circuits I  
EE 311 Electronic Devices and Circuits II  
EE 352 Introduction to Electronics Lab  
EE 353 Electronic Circuits Lab  
EE 410 Electronic Instrument Design I  
MAE 335 Fluid Mechanics  
MTH 141 College Calculus I  
MTH 142 College Calculus II  
MTH 241 College Calculus III  
MTH 306 Introduction to Differential Equations  
MTH 417 Survey of Multivariable Calculus  
MTH 418 Survey of Partial Differential Equations  
PHY 107 General Physics I or PHY 117 Honors Physics I  
PHY 108 General Physics II or PHY 118 Honors Physics II  
PHY 158 General Physics II Lab  
PHY 207 General Physics III or PHY 217 Honors Physics III  
PHY 208 General Physics IV  
PHY 257 General Physics III Lab  
PHY 301 Intermediate Mechanics I  
PHY 307 Modern Physics Lab  
PHY 401 Modern Physics I  
PHY 402 Modern Physics II  
PHY 403 Electricity and Magnetism I  
PHY 404 Electricity and Magnetism II  
PHY 405 Thermal and Statistical Physics I  
PHY 407 Advanced Laboratory or PHY 408 Advanced Laboratory  
Three technical electives

## RECOMMENDED SEQUENCE FOR BS IN ENGINEERING PHYSICS MAJOR REQUIREMENTS

### First Year

Fall	Spring
CHE 107 General Chemistry for Engineers	CHE 108 General Chemistry for Engineers
EAS 140 Engineering Solutions	MTH 142 College Calculus II
MTH 141 College Calculus I	PHY 108 General Physics II <b>or</b> PHY 118 Honors Physics II (preferred)
PHY 107 General Physics I <b>or</b> PHY 117 Honors Physics I (preferred)	PHY 158 General Physics II Lab
Gen Ed*	EAS 202
	Gen Ed*

### Second Year

EE 202 Circuit Analysis I	EAS 230 Higher-Level Language
MTH 241 College Calculus III	PHY 207 General Physics III <b>or</b> PHY 217 Honors Physics III
MTH 306 Introduction to Differential Eqns.	PHY 257 General Physics III Lab
PHY 208 General Physics IV	MTH 418 Survey of Partial Differential Eqns.
Gen Ed*	Technical Elective

### Third Year

EE 310 Electronic Devices and Circuits I	EE 311 Electronic Devices and Circuits II
EE 352 Introduction to Electronics Lab	EE 353 Electronic Circuits Lab
PHY 301 Intermediate Mechanics I	two Gen Eds*
PHY 401 Modern Physics I	PHY 307 Modern Physics Lab
MTH 417 Survey of Multivariable Calculus	PHY 402 Modern Physics II

### Fourth Year

EE 410 Electronic Instrument Design I	Gen Ed*
MAE 335 Fluid Mechanics	PHY 404 Electricity and Magnetism II
PHY 403 Electricity and Magnetism I	Technical Elective
PHY 405 Thermal and Statistical Physics I	Technical Elective
Gen Ed*	PHY408 Advanced Laboratory

\*See the School of Engineering and Applied Sciences academic requirements section in the UB catalogue.

### TECHNICAL ELECTIVES

Technical electives can be chosen from the approved list of required courses or approved technical electives for either the B.S. in physics or the B.S. in electrical engineering program. At least one technical elective must

be chosen from the electrical engineering list. Recommended technical electives appropriate to this program are: EE 489, EE 490, PHY 425 Intermediate Optics, PHY 406 Thermal and Statistical Physics II, PHY 407 Advanced Laboratory.

**SUMMARY of Credit Hours**

Total required credit hours in math, physics, chemistry and engineering	111
Total required credit hours	129

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## COMPUTATIONAL PHYSICS – B.S.

**Acceptance Criteria:** GPA of 2.5 in CSE 115–116, MTH 141–142, PHY 107–108/158.

### REQUIRED COURSES

CSE 115 Introduction to Computer Science for Majors I  
 CSE 116 Introduction to Computer Science for Majors II  
 CSE/MTH 191 Introduction to Discrete Mathematics  
 CSE 250 Algorithms and Data Structures  
 CSE 305 Introduction to Programming Languages  
 CSE/MTH 437 Introduction to Numerical Analysis I or PHY 410 Computational Physics I  
 CSE/MTH 438 Introduction to Numerical Analysis II or PHY 411 Computational Physics II  
 CSE 442 Software Engineering  
 MTH 141 College Calculus I  
 MTH 142 College Calculus II  
 MTH 241 College Calculus III  
 MTH 306 Introduction to Differential Equations  
 MTH 309 Introductory Linear Algebra  
 PHY 107 General Physics I or PHY 117 Honors Physics I  
 PHY 108 General Physics II or PHY 118 Honors Physics II  
 PHY 158 General Physics II Lab  
 PHY 207 General Physics III or PHY 217 Honors Physics III  
 PHY 208 General Physics IV  
 PHY 257 General Physics III Lab  
 PHY 301 Intermediate Mechanics I  
 PHY 307 Modern Physics Lab  
 PHY 401 Quantum Mechanics I-fundamentals  
 PHY 403 Electricity and Magnetism I  
 PHY 405 Thermal and Statistical Physics I  
 PHY 407 Advanced Laboratory or PHY 408 Advanced Laboratory  
 One elective (Choose a calculus-based probability/statistics course, e.g., EAS 305 Applied Probability or MTH 411 Probability Theory)

### RECOMMENDED SEQUENCE FOR BS IN COMPUTATIONAL PHYSICS MAJOR REQUIREMENTS

#### First Year

Fall	Spring
CSE 115 Introduction to Computer Science for Majors I	CSE 116 Introduction to Computer Science for Majors II
MTH 141 College Calculus I	MTH 142 College Calculus II

PHY 107 General Physics I <b>or</b> PHY 117 Honors Physics I (preferred)	PHY 108 General Physics II <b>or</b> PHY 118 Honors Physics II (preferred)
ENG 101 or 201*	PHY 158 General Physics II Lab
Library Skills	ENG 201 or Humanities*

### Second Year

CSE/MTH 191 Introduction to Discrete Mathematics	CSE 250 Algorithms and Data Structures
MTH 241 College Calculus III	PHY 207 General Physics III <b>or</b> PHY 217 Honors Physics III
MTH 306 Intro to Differential Equations	PHY 257 General Physics III Lab
PHY 208 General Physics IV	UGC 112
UGC 111	Social Science

### Third Year

CSE 305 Intro to Programming Languages	MTH 309 Introductory Linear Algebra
PHY 301 Intermediate Mechanics I	PHY 307 Modern Physics Lab
PHY 401 Quantum Mechanics I	Elective (Calculus-based prob/stat course)
CSE 442 Software Engineering	UGC 211 or American Pluralism
Language 1	Language 2

### Fourth Year

PHY 403 Electricity and Magnetism I	CSE/MTH 438 Introduction to Numerical Analysis II <b>or</b> PHY 410(F) <b>or</b> (Sp) Computational Physics I** PHY 411 Computational Physics II
PHY 405 Thermal and Statistical Physics I	PHY 407(F) <b>or</b> 408(Sp) Advanced Laboratory
CSE/MTH 437 Introduction to Numerical Analysis I or PHY	Arts Gen Ed

\*Students placed into ENG 101 should take ENG 101 in the fall and ENG 201 in the spring. Students placed in ENG 201 should take ENG 201 in the fall and a Humanities Gen Ed in the spring.

\*\*PHY410 Could be offered during the Spring or Fall semesters.

### SUMMARY of Credit Hours

Total required credit hours in computer science, mathematics, and physics	87-90
General education courses and electives	33-30
Total required credit hours	120

## 5 YEAR BS IN COMPUTATIONAL PHYSICS/MS IN PHYSICS

**Acceptance Criteria:** Minimum GPA of 3.0 in CSE 115-116, CSE/MTH 191, MTH 141-142-241, and PHY 107-108/158-207/257

### REQUIRED COURSES

CSE 115 Introduction to Computer Science for Majors I  
CSE 116 Introduction to Computer Science for Majors II  
CSE/MTH 191 Introduction to Discrete Mathematics  
CSE 250 Algorithms and Data Structures  
CSE 305 Introduction to Programming Languages  
CSE 442 Software Engineering  
MTH 141 College Calculus I  
MTH 142 College Calculus II  
MTH 241 College Calculus III  
MTH 306 Introduction to Differential Equations  
MTH 309 Introductory Linear Algebra  
PHY 107 General Physics I or PHY 117 Honors Physics I  
PHY 108 General Physics II or PHY 118 Honors Physics II  
PHY 158 General Physics II Lab  
PHY 207 General Physics III or PHY 217 Honors Physics III  
PHY 208 General Physics IV  
PHY 257 General Physics III Lab  
PHY 301 Intermediate Mechanics I  
PHY 307 Modern Physics Lab  
PHY 401 Quantum Mechanics I-fundamentals  
PHY 403 Electricity and Magnetism I  
PHY 405 Thermal and Statistical Physics I  
Elective (Calculus-based probability/statistics course, e.g., EAS 305 Applied Probability or MTH 411 Probability Theory)  
PHY 505 Computational Physics I  
PHY 506 Computational Physics II  
PHY 515 High Performance Scientific Computing I  
PHY 516 High Performance Scientific Computing II  
PHY 551 or PHY 552 Graduate Lab  
15 Credits of PHY 500 (electives and M.S. thesis)

**RECOMMENDED SEQUENCE OF BS IN COMPUTATIONAL PHYSICS/MS IN PHYSICS  
MAJOR REQUIREMENTS**

**First Year**

Fall	Spring
CSE 115 Introduction to Computer Science for Majors I	CSE 116 Introduction to Computer Science for Majors II
MTH 141 College Calculus I	MTH 142 College Calculus II
PHY 107 General Physics I <b>or</b> PHY 117 Honors Physics I (preferred)	PHY 108 General Physics II <b>or</b> PHY 118 Honors Physics II (preferred)
ENG 101 or 201*	PHY 158 General Physics II Lab
	ENG 201 or Humanities Gen Ed*

**Second Year**

CSE/MTH 191 Introduction to Discrete Mathematics	CSE 250 Algorithms and Data Structures
MTH 241 College Calculus III	PHY 207 General Physics III <b>or</b> PHY 217 Honors Physics III
MTH 306 Intro to Differential Equations	PHY 257 General Physics III Lab
PHY 208 General Physics IV	UGC 112
UGC 111	Social Science

**Third Year**

CSE 305 Intro to Programming Languages	MTH 309 Introductory Linear Algebra
PHY 301 Intermediate Mechanics I	Elective (Calculus-based probability/statistics course)
PHY 401 Modern Physics I	PHY 307 Modern Physics Lab
UGC 211 or American Pluralism	Language 2
Language 1	

**Fourth Year**

CSE 442 Software Engineering	PHY 506 Computational Physics II
PHY 403 Electricity and Magnetism I	PHY 551(F) or PHY 552 (Sp) Graduate Lab
PHY 405 Thermal and Statistical Physics I	PHY 500-level Elective and M.S. Thesis
PHY 505 Computational Physics I	
Arts Gen Ed	

**Fifth Year**

PHY 515 High Performance Scientific Computing I	PHY 516 High Performance Scientific Computing II
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PHY 500-level Elective and M.S. Thesis	PHY 500-level Elective and M.S. Thesis
PHY 500-level Elective and M.S. Thesis	PHY 500-level Elective and M.S. Thesis

\*Students placed into ENG 101 should take ENG 101 in the fall and ENG 201 in the spring. Students placed into ENG 201 should take ENG 201 in the fall and a Humanities Gen Ed in the spring.

**SUMMARY of Credit Hours**

Total required Undergraduate credit hours in:	
computer science, mathematics, and physics	78
General education courses and electives	32
Graduate credit hours	30
Total required credit hours	140

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## IV. GENERAL EDUCATION REQUIREMENTS

A student's requirements are determined by the academic year of entry to U.B. For details, see the Archived Catalogs at <http://undergrad-catalog.buffalo.edu>. Questions on your Gen-Ed requirements should be directed to the CAS Office of Student Advisement Services at <http://casadvising.buffalo.edu>.

**For All Students Who Enter Fall 2013 and Spring 2014, the Gen. Ed. Requirements as listed at <http://undergrad-catalog.buffalo.edu/policies/degree/gened.shtml> are:**

### Writing

Complete ENG 101 and ENG 201, as placed, unless exempted.

### Library Skills

Complete the Library Skills Workbook within the first year of study at UB.

### Mathematical Sciences

Complete one course from the following lists.

Recommended Courses for Students Who are Not Meeting a Specific Requirement of a Major

- CSE 111 Great Ideas in Computer Science I
- STA 119 Introduction to Statistics

Additional Courses that Satisfy the Mathematical Sciences Requirement

- CEP 207 or GEO 410 or MGQ 301 or PSC 408 or PSY 207 or SOC 294 or SOC 404 or SSC 225 or STA 111 - STA 112\*
- CSE 113 Introduction to Computer Science I
- CSE 115 Introduction to Computer Science for Majors I
- CSE 116 Introduction to Computer Science for Majors II
- CSE 191 Introduction to Discrete Structures
- MTH 115 or ULC 148 Survey of Algebra and Trigonometry

- MTH 121 or MTH 131 or MTH 141 or MTH 153\*
- MTH 122 or MTH 142 or MTH 154\*
- MTH 181 Conceptual Mathematics I
- PHI 315 Symbolic Logic
- PHI 415 Logical Theory I
- PHI 416 Logical Theory II

*\*Courses grouped together are equivalent courses. Students should not take more than one course from each group*

### **World Civilizations**

Complete UGC 111 and UGC 112 World Civilizations I-II. (\*\*See note at end of this section.)

### **Natural Sciences**

Students must complete a two-course sequence, including at least one semester of laboratory. Allowable two-course sequences are outlined in lists below.

Recommended Course Sequences for Students Who Are Not Meeting a Specific Requirement of a Major

- BIO 129 - BIO 130 Perspectives in Human Biology
- GEO 101 and GEO 106 Physical Environmental Geography
- GLY 101 - GLY 102 Global Environmental Science
- NTR 108 - NTR 109/NTR 110 Human Nutrition/Nutrition in Practice
- PHY 121 - PHY 122 Descriptive Astronomy

Additional Course Sequences that Satisfy the Natural Sciences Requirement

- BIO 200 Evolutionary Biology and BIO 201 Cell Biology
- BIO 200 Evolutional Biology and BIO 309 Ecology
- CHE 101 - CHE 102 General Chemistry
- CHE 105 - CHE 106 Chemistry: Principles and Applications

- CHE 107 - CHE 108 General Chemistry for Engineers
- GLY 103 - GLY 104 Evolution of the Earth and Solar System
- PHY 101/PHY 151 - PHY 102/PHY 152 College Physics I-II/Lab
- PHY 107 - PHY 108/PHY 158 General Physics I-II/Lab
- PHY 117 - PHY 118/PHY 158 Honors Physics I-II/Lab

*Note: School of Architecture majors only may complete ARC 352 and PHY 101; Nursing majors only may complete ANA 113 and PGY 300. School of Public Health and Health Profession majors only may complete ES 207 and PGY 300.*

### **American Pluralism or Cognate (approved equivalent courses)**

Complete UGC 211 American Pluralism and the Search for Equality or any one of the following: AAS 261, ARC 211, AHI 390, DMS 213, GEO 231, HIS 161, HIS 162, LIN 200, SOC 211, TH 220. (\*\*See note at end of this section.)

*Note: UGC 111 - UGC 112 World Civilizations I-II should be completed first.*

### **Social and Behavioral Sciences**

Complete one 3-credit course offered by APY, CDS, COM, ECO, GEO, LIN, PSC, PSY, SSC, or SOC; or ARC 122, PD 120, PD 212.

Note: Courses used to satisfy any other general education requirement are excluded.

### **Language Requirement**

NOTE: See the Foreign Language Placement section of the catalog for appropriate placement level.

For native speakers of English, students must demonstrate elementary-level proficiency in a language other than English by doing one of the following:

- Completing a 2-semester first-year sequence of college-level courses in a language other than English (e.g. Spanish 101-102, Modern Greek 191-192).

- Completing a 1-semester college-level Transitional or Heritage language course (Spanish 104, 171, French 104, German 104, Italian 106, Chinese 104 or 105, Russian 104).
- Achieving a minimum score of 600 on a College Board Foreign Language Achievement Test
- Achieving a minimum score of 3 or 4 (depending upon the language and the test) on an AP test in a foreign language

Native speakers of English and native speakers of other languages may also demonstrate proficiency in a language other than English by doing one of the following:

- Showing a high school diploma from a country whose language of instruction is other than English
- Passing a proficiency examination administered by the department which houses the appropriate language. Romance Languages and Literatures: French, Spanish, Italian and Portuguese; Classics: Latin, Ancient Greek; Jewish Studies: Hebrew; Linguistics: all other languages taught at UB. It is suggested that students contact the relevant department to arrange for the proficiency examination as soon as they are in residence at UB. For speakers of languages not taught at UB, see the College of Arts and Sciences Office of Student Advisement and Services.

*Note: Majors in the following schools and programs are not required to complete language study: Architecture; B.F.A. in Art, Dance, Music Theatre; Bioinformatics and Computational Biology; Biomedical Sciences; Biotechnology; Engineering (except Computer Science); Informatics; Management; Medical Technology; Medicinal Chemistry; Nuclear Medicine Technology; Nursing; Pharmacology and Toxicology; Pharmacy and Pharmaceutical Sciences; Public Health and Health Professions.*

*Note: Some majors and minors require additional semesters of language study.*

## Humanities

Students completing ENG 101 and ENG 201 have met this requirement; other students must complete one 3-credit course offered from AAS, AS, AMS, CL, COL, ENG (excluding ENG 101/ENG 201), FR, GER, GGS, HIS, HMN, ITA, JDS, LLS, PHI, RSP, SPA, TNS, WLP, and other languages.

Note: Courses used to satisfy any other general education requirement are excluded.

## Arts

Complete one 3-credit course offered by ART, AHI, DMS, MTR, MUS, TH, or THD; VS; ARC 121 is also an option. (\*\*See note at the end of this section.)

Note: Courses used to satisfy any other general education requirement are excluded.

## Depth Requirement

Complete any one of the following:

- Third-semester language proficiency (e.g. SPA 151)
- An additional course from the listing of mathematical sciences courses
- UGC 302 or UGC 303 Great Discoveries in Science
- A natural sciences course numbered 200 or higher
- Any one of the following courses: ANA 407, APY 310, APY 328, APY 338, APY 344, APY 345, APY 348, APY 350; ARC 442; CDS 288, CDS 382; GEO 345, GEO 347, GEO 348, GEO 350, GEO 352, GEO 356, GEO 435, GEO 449; MT 402; PSY 351, PSY 402, PSY 434, PSY 435, PSY 436, PSY 439

Note: Courses used to satisfy any other general education requirement are excluded. Transfer courses must be articulated (i.e., matched) to specific UB courses or requirements in order to satisfy UB's Depth Requirement. SUNYGE waivers do not apply toward UB's Depth Requirement. Students may not petition this policy.

*\*\*Note: Students who entered UB with 24 or more transferable credit hours from an institution of higher education other than UB are exempted from the World Civilizations, American Pluralism, and Arts requirements. These credits must have been earned prior to enrollment at UB.*

## **General Education Requirements**

Requirements differ by student status. Please note that there are different requirements for: (1) students who enter as freshmen; (2) students who enter as transfer students; (3) students who enter as transfer students with a completed AA or AS degree from a SUNY institution and with a GETA (General Education Transcript) showing completion of all SUNY general education requirements; (4) re-entering students who were recently enrolled at UB; (5) re-entering students last enrolled more than five years ago; (6) students enrolled for a second bachelor's degree; (7) students enrolled who have a completed bachelor's degree from a foreign institution; and (8) students with a registered learning disability. See an academic advisor for details.

## **General Education Advising Notes**

S/U grading is not an option in any course used to satisfy General Education requirements.

Internship, Independent Study, Undergraduate Teaching, Experiential Learning, and other courses not based on classroom experiences may not be used to meet General Education requirements.

Any given course may be applied toward only one General Education requirement unless explicitly noted otherwise.

Only the specified courses or those that articulate to the specified courses listed for each respective General Education requirement may be used to fulfill that particular requirement. No other courses qualify.

SUNY has established *minimum* General Education requirements for campuses across the SUNY system. UB's General Education program meets, and in many cases exceeds, these requirements. Students should understand that meeting SUNY General Education requirements at other campuses does not necessarily mean that they have met all of UB's requirements or that they are exempt from certain UB requirements.

## V. GENERAL GUIDELINES

The recommended course sequences given in Sec. III are to be used as guidelines. It is not necessary to follow them precisely; however, if you wish to deviate from them it is essential that you check with the Undergraduate Director, Professor Cerne, before doing so. This is especially important if you are signed up for the Finish in Four plan. This will prevent you from making a serious mistake. Here are a few general guidelines:

(i) Take *Modern Physics* (PHY 401–402) in the Junior year. It is necessary to have taken PHY401 before taking *Advanced Lab* (PHY 407, 408), *Nuclear and Particle Physics* (PHY 412), or *Solid State Physics* (PHY 434 or PHY 527–528).

(ii) Take two semester courses such as PHY 301–302 in sequence rather than waiting a year to take the second semester. This ensures continuity.

(iii) Distribute physics, math and other technical courses as evenly as possible throughout your program. This makes life easier.

(iv) Take MTH 309 *Introductory Linear Algebra* even if you are not a Mathematical Physics or Computational Physics Major. This course helps greatly in understanding quantum mechanics and certain areas of classical mechanics.

(v) Consider taking a Minor in Math. If you pursue the BS in Physics it is only necessary to add MTH 309 to your program in order to complete this minor.

(vi) Take some sort of computer-based course so as to develop at least minimal programming skills, and some knowledge of numerical methods. If possible, take at least one semester of PHY 410–411, *Computational Physics*.

(viii) Consult with the Undergraduate Director, Professor Cerne, on a regular basis so as to make sure that you are fulfilling the requirements of the major. Those signed up for the Finish in Four plan must make an appointment with their advisor within the first 3 weeks of each term. Engineering Physics students should also consult with a SEAS Advisor in 410 Bonner Hall. For problems arising in connection with General Education Requirements, it is best to consult with Ms. Pamela Wendling, Senior Academic Advisor, Natural Sciences Services ([pwendlin@buffalo.edu](mailto:pwendlin@buffalo.edu), 645-6883, 275 Park Hall). She is on the staff of the Dean of the College of Arts and Sciences.

(ix) Check your HUB AAR report regularly. If you find what appears to be an error in your report, bring it to Professor Cerne's attention.

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## **VI. PROCEDURES FOR APPLYING TO DEGREE PROGRAMS**

For the BS, BA, and Minor in Physics; as well as the BS in Mathematical Physics, the BS in Computational Physics, the 5 year BS in Computational Physics/MS in Physics, and the BA's in the Teaching of Science; the application to a degree program is processed by the Undergraduate Director for Physics, Professor Cerne. Simply inform him of your intended physics major, and that you have finished the prerequisite courses with the with a minimum GPA of 2.0. After confirming this on your HUB record, he will accept you to this major. For the Teaching of Science programs an application for the Minor in Education must be filed with the Teacher Education Institute (TEI) in 379 Baldy Hall.

The application for the Engineering Physics program is initiated either through Professor J. Bird (312 Bell Hall; 645-2422 X 2132) of the Electrical Engineering Department, or through SEAS Undergraduate Student Services in 410 Bonner Hall.

Upon being accepted into a degree program, the student will receive an e-mail confirming the acceptance. Once accepted be sure to check with the Undergraduate Director (Professor Cerne) at least once a semester before registering for the following semester. Again for Finish in Four, you must do this.

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## **VII. DEPARTMENT HONORS AND SENIOR THESIS**

In order to graduate with Departmental Honors a student must excel in course work as well as complete a Senior Thesis. The designations given below are awarded to students who have the corresponding grade point averages in courses required for the degree programs of the Department of Physics and have completed a Senior Thesis.

Honors	3.25
High Honors	3.50
Highest Honors	3.75

The Senior Thesis is prepared under the supervision of a Department of Physics faculty member. Credit for this is obtained through PHY 497-Honors. The thesis is reviewed by the student's mentor and the Undergraduate Director. The thesis should be at least 20 pages long and the student must have completed at least one semester of PHY 497. The student does not need to be in the Honors College to complete a senior thesis and will graduate with honors if his/her GPA is above 3.25.

Those students who successfully complete the Physics Honors Program will receive recognition at graduation, and awards will be given at the reception held each year for the BA and BS recipients of the Department of Physics.

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## VIII. UNDERGRADUATE RESEARCH

Most of the faculty of the Department of Physics are willing to engage undergraduate students in their research activities. Interested students should check out the web page located at <http://www.physics.buffalo.edu/undergraduate/UndergraduateResearchMentors.htm>. This web page describes the Undergraduate Research Mentors program of the Department of Physics. Students can get credit for undergraduate research by registering for PHY 498 Undergraduate Research.

There are also many opportunities for undergraduates to pursue research at UB, through the university's Center for Undergraduate Research and Creative Activities (CURCA). You may inquire at <http://curca.buffalo.edu>.

Another way to get research experience is to participate in the Research Experiences for Undergraduates (REU) program sponsored by the National Science Foundation (NSF). With this program various universities provide summer research opportunities for undergraduate students. The list of universities that have such a program is at <http://www.nsf.gov/home/crssprgm/reu/>. The web page for each program describes how to apply, along with the research areas and stipends that are available. Besides the stipend many programs provide housing and a travel allowance.

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## IX. ADVICE ON GRADUATE SCHOOL

Most physics students go on to graduate school after they complete their BA or BS degree. If you plan to do so, you should begin making preparation in the spring of your junior year.

You can obtain information on graduate programs from sources such as *Graduate Programs in Physics, Astronomy, and Related Fields* (American Institute of Physics; Woodbury, New York), *Graduate Programs in the Physical Sciences, Mathematics & Agricultural Sciences* (Peterson's; Princeton, New Jersey), as well as brochures from physics departments. The Department of Physics keeps a file of brochures that you are free to examine. Probably the best way to obtain information is by talking to professors in our department, and if possible, to professors in other physics departments. Most departments are happy to have you visit them. In recent years the World Wide Web has become an invaluable source of information on graduate programs.

Many graduate programs require you to take the *Graduate Record Exam* (GRE), which is administrated by the *Educational Testing Service*. Their address is:

Graduate Record Examinations  
Educational Testing Service  
PO Box 6000  
Princeton, NJ 08541-6000

Information on the exams can be obtained by telephoning the Educational Testing Service on 1-866-473-4373, or by sending them inquires at [gre-info@ets.org](mailto:gre-info@ets.org), or by checking out their web site at <http://www.ets.org/gre>.

For physics students there are two GRE's of interest, the General Test and the Physics Test. It is important to study for the GRE. You should obtain an old exam, and use it to guide you in your studying, as well as for practice.

Most graduate programs have deadlines for their applications that occur in January or early February. It is important that you get your applications in on time. In general it is necessary to provide three or four letters of recommendation from professors who have taught you, or that you have worked with during your undergraduate years. In this connection it is important to make yourself known. If the only thing a professor knows about you is your grade in a course, he or she cannot write a very useful letter. If at all possible you should get involved in the research activities of one or more faculty members; either by working for them, or by doing a Senior Thesis. If you decide to do a Senior Thesis you should start work in the fall of your senior year, if not sooner, as this gives a faculty member time to get to know you before writing a letter of recommendation. It is a good idea to provide a résumé and a transcript to anyone that you ask to write a letter of recommendation.

Graduate students are usually supported by teaching assistantships (TA's), research assistantships (RA's), by fellowships, or a combination of these. It is safe to say that a physics student from UB with a B or better average in the courses required by the Department of Physics can get into a reputable graduate program in physics, that will provide a TA. In general a TA includes a tuition waiver and a modest salary. Some graduate programs also guarantee summer employment, as well as health benefits.

There are two types of fellowships; those that are offered by the graduate programs, and national fellowships. Obviously, graduate programs offer their fellowships to their best applicants. In general, the national fellowships can be used for any graduate program that accepts you. In fact getting such fellowships improves your chance of acceptance. Information on the national fellowships can be obtained from the office of the University Honors Program 106 Capen Hall, <http://honors.buffalo.edu>, or <http://fellowships.buffalo.edu>. Below is a list of well-known national fellowships:

AT & T Bell Labs  
Danforth Foundation  
Hertz Foundation  
National Science Foundation Graduate Research Fellowship  
Department of Defense - National Defense Science & Engineering Graduate Fellowship Program (NDSEG)  
Fulbright Fellowship  
Goldwater Fellowship

## APPENDIX A.

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### ACCEPTANCE CRITERIA FOR TRANSFER STUDENTS

1. Transfer students from accredited institutions will be granted admission to the Department of Physics if they satisfy the following requirements with an average of 2.0 or better:
    - a. A one-year calculus-based physics course similar to our PHY 107-108/158.
    - b. A one-year calculus course similar to MTH 141-142.
  2. For transfer students with more than the minimum course work listed in 1a & b, admission will be granted if the student has an average of 2.0 or better in all physics and mathematics courses previously attempted.
  3. Academic Transfer credit will be granted for physics and mathematics courses, suitable to our degree programs, only for those courses in which the grade was C or better.
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## APPENDIX B.

**Not all courses are offered every year and some fall(spring) courses may be offered in spring(fall), so please check current course catalog for up-to-date course offerings.**

To request Force Registration for a repeatable course, Registration for PHY 497 Honors, PHY 498 Undergraduate Research (1-3 credits), or PHY 499 Independent Study in Physics (1-4 credits):

You need to email Nicole D Pannullo at [ndmercer@buffalo.edu](mailto:ndmercer@buffalo.edu) with

- Your person #
- The semester force is being requested
- The 5 digit registration # for the course
- Name of the course
- # of credits (if applicable)
- Reason

For Force Registration in lecture based courses provide the 5 digit registration # for the recitation, not the lecture. Enrolling in the recitation automatically enrolls you in the associated lecture.

Recitation + Lecture = the Course. Labs are a separate course that you register for separately. We are not able to force register in to labs due to equipment and space limitations. Due to the # of requests we receive please do not call or visit the department to request force registration. Please do not email individual instructors to request force registration. Nicole D Pannullo is the only person that can force register in the Department of Physics. If your force selection is not available, the Department suggests that you pick a different section or if no other section fits your schedule, take the course another semester.

PHY 100, 101, 102, 107, 108, 151, 152, 158, and 257 are all usually offered over summer.

PHY 100, 101, 102, 107, and 108 are usually offered over winter.

Information on registering for summer or winter sessions can be located at the University at Buffalo's website:

<http://registrar.buffalo.edu/registration/>

## COURSE DESCRIPTIONS

### **PHY 100 Introduction to Physics**

Credits: 1

Semester: Su

Prerequisites: None

Corequisites: None

Type: LEC

Repeatable: No

Note: None

Preparation for PHY 107-PHY 108 or PHY 101-PHY 102. Covers mostly Newtonian mechanics, emphasizing problem solving and math skills useful for physics. Reviews algebra, geometry, and trigonometry as applied to physics.

### **PHY 101 College Physics**

Credits: 4

Semester: F Sp

Prerequisites: None

Corequisites: PHY 151

Type: LEC/REC

Repeatable: No

Note: None

Presents non-calculus, introductory physics, including mechanics, heat, waves, and sound. This course satisfies 4 credits as required by different majors, and also 4 credits (out of the mandated 7 credits total) of UB's Scientific Literacy & Inquiry Sequence general education requirements. This course is a controlled enrollment (impacted) course. Students who have previously attempted the course and received a grade other than W may only repeat the course in the winter or summer. Repeating in the fall or spring semester can be requested by petition submitted through the Dept. to CAS.

### **PHY 102 College Physics II**

Credits: 4

Semester: Sp

Prerequisites: PHY 101

Corequisites: PHY 152

Type: LEC/REC

Repeatable: No

Note: None

Presents non-calculus, introductory physics, including electricity and magnetism, light, optics, and modern physics. This course satisfies 4 credits as required by different majors, and also 4 credits (out of the mandated 7 credits total) of UB's Scientific Literacy & Inquiry Sequence general education requirements.

### **PHY 107 General Physics I**

Credits: 4

Semester: F Sp

Prerequisites: None

Corequisites: MTH 141

Type: LEC/REC

Repeatable: No

Note: None

A calculus-based introductory course primarily for chemistry, engineering, and physics majors. Covers kinematics, Newton's laws, energy, momentum, rotational motion, and oscillations. This course satisfies 4 credits as required by different majors and also 4 credits (out of the mandated 7 credits total) of UB's Science Literacy and Inquiry general education requirement sequence. Enrollment is not allowed in PHY107 if a student has current enrollment in PHY101.

### **PHY 108 General Physics II**

Credits: 4

Semester: F Sp

Prerequisites: PHY 107

Corequisites: MTH 142, PHY 158

Type: LEC/REC

Repeatable: No

Note: None

A calculus based introductory course primarily for chemistry, engineering, and physics majors. Covers the electric field, Gauss' law, electric potential, capacitance, DC circuits, RC circuits, magnetic field, Faraday's law, inductance, LR circuits, AC circuits, and Maxwell's equations. This course satisfies 4 credits as required by different majors and also 4 credits (out of the mandated 7 credits total) of UB's Science Literacy and Inquiry general education

requirement sequence.

### **PHY 115 Relativity Seminar for Nonspecialists**

Credits: 3

Semester: F

Prerequisites: None

Corequisites: None

Type: SEM

Repeatable: No

Note: None

Examines philosophies of space and time, Mach's principle and the role of inertia, curved space-time, unified field theory (Faraday to Einstein), and implications of extension in all domains.

### **PHY 116 Philosophy of Physics**

Credits: 3

Semester: Sp

Prerequisites: None

Corequisites: None

Type: LEC

Repeatable: No

Note: None

Studies views of space, time, and matter in the ancient world; European post-Renaissance, nineteenth-century ideas and discoveries; wave-particle dualism; wave mechanics; Copenhagen school; theory of relativity; and problems of matter, radiation, and cosmology.

### **PHY 117 Honors Physics I**

Credits: 4

Semester: Sp

Prerequisites: PHY 117 is especially appropriate for students who have taken AP Physics C in high school.

Corequisites: MTH 141

Type: LEC/REC

Repeatable: No

Note: None

PHY 117 is a calculus based Honors physics course, which covers similar topics as PHY 107, but in greater depth. This course is intended for potential physics majors, students in the honors college, and advanced students in other majors (with permission from the instructor).

The class will be taught at a level comfortable for students who would receive a B or higher in a typical PHY 107 class. Because of the higher average GPA of students in this class, grading will be adjusted to reflect this quality, rather than following the conventional curves used for PHY 107. Introductory materials, such as review of trigonometry, vectors and calculus, in PHY 107 will not be covered. This leaves room to expose students to a wider range of interesting applications of Newtonian mechanics, and recent developments in topics such as Special Relativity and Cosmology. The class size is limited, to encourage interactive learning and communications between students and the instructor. This course satisfies 4 credits (out of the mandated 7 credits total) of UB's Science Literacy and Inquiry General Education requirements. Enrollment is not allowed in PHY117 if a student has current enrollment in PHY107.

### **PHY 118 Honors Physics II**

Credits: 4

Semester: F

Prerequisites: PHY 107 or PHY 117

Corequisites: MTH 142, PHY 158

Type: LEC/REC

Repeatable: No

Note: None

PHY 118 is a calculus based Honors physics course, which covers the same topics in electricity and magnetism as PHY 108, but in greater depth. Class size is limited. In general taken by students in the University Honors College, but other students may take it with permission of instructor. This course satisfies 4 credits as required by different majors and also 4 credits (out of the mandated 7 credits total) of UB's Science Literacy and Inquiry sequence general education requirements. Enrollment is not allowed in PHY118 if a student has current enrollment in PHY108.

### **PHY 119 How Things Work**

Credits: 3

Semester: F  
Prerequisites: None  
Corequisites: None  
Type: LEC  
Repeatable: No  
Note: None

Describes working principles of devices used in everyday life, such as the video recorder, fax machine, and television. Reviews the history of discoveries that made each device possible, as well as development of the device. Explores the consequences of particular devices in society. Suitable for non-science majors, but science and engineering majors are expected to greatly benefit from it also.

### **PHY 121 Descriptive Astronomy I**

Credits: 3 - 4  
Semester: F  
Prerequisites: None  
Corequisites: None  
Type: LEC/LAB  
Repeatable: No  
Note: None

PHY 121 is the first semester of a two-semester survey of astronomy. In PHY 121 we study the sky, the history of astronomy, telescopes and light, and the origin and structure of the Solar System. As part of the laboratory, each student is given a required telescope observation appointment. This course plus the second semester PHY 122 course satisfy UB's 7-credit Science Literacy and Inquiry general education requirement.

### **PHY 122 Descriptive Astronomy II**

Credits: 3 - 4  
Semester: Sp  
Prerequisites: PHY 121  
Corequisites: None  
Type: LEC/LAB  
Repeatable: No  
Note: None

PHY 122 is the second semester of a two-semester survey of astronomy. In PHY 122 we study the stars and stellar evolution, the sun, neutron stars and black holes, cosmology, and life in the universe. As part of

the laboratory, each student is given a required telescope observation appointment. This course plus the first semester PHY 121 course satisfy UB's 7-credit Science Literacy and Inquiry general education requirement.

### **PHY 151 College Physics I Lab**

Credits: 1  
Semester: F  
Prerequisites: PHY 101  
Corequisites: PHY 101  
Type: LAB  
Repeatable: No  
Note: None

PHY-151 is an introductory Physics lab course. This course covers mechanics, kinematics, forces, vectors and heat. Experiments are used to demonstrate principles discussed in the lecture course PHY 101. PHY 151 satisfies the SLI General Education 1-credit laboratory requirement (out of the 7 credits total SLI Gen-Ed requirement).

Course Prerequisites: PHY 151 has the lecture course PHY-101 as either a pre-requisite or a co-requisite. (Note: PHY-101 is also a pre-requisite for the second semester lecture PHY-102.) The PHY-151 laboratory and PHY-101 lecture courses deal with related topics, however PHY 151 is separate from the lecture. Registration for lecture does not automatically register you for lab and vice versa.

### **PHY 152 College Physics II Lab**

Credits: 1  
Semester: Sp  
Prerequisites: PHY 102  
Corequisites: PHY 102  
Type: LAB  
Repeatable: No  
Note: None

PHY-152 is an introductory Physics lab course. This course covers electricity, magnetism and optics. Experiments are used to demonstrate principles discussed in the lecture course PHY 102. PHY-152

satisfies the SLI General Education 1-credit laboratory requirement (out of the 7 credits total SLI Gen-Ed requirement).

Course Prerequisites: PHY 152 has the lecture course PHY-102 as either a pre-requisite or a co-requisite (additionally, PHY-102 has PHY-101 as a pre-requisite). The PHY 152 laboratory and the PHY 102 lecture courses deal with related topics, however PHY 152 is separate from the lecture. Registration for lecture does not automatically register you for lab and vice versa.

### **PHY 158 General Physics II Lab**

Credits: 1

Semester: F Sp

Prerequisites: PHY 107

Corequisites: PHY 108

Type: LAB

Repeatable: No

Note: None

PHY-158 is an introductory Physics lab course. This course covers mechanics, kinematics, forces, vectors, electricity and magnetism. Experiments are used to demonstrate principles discussed in the lecture courses PHY 107 and PHY 108. PHY-158 satisfies the SLI General Education 1-credit laboratory requirement (out of the 7 credits total SLI Gen-Ed requirement).

Course Prerequisites: PHY-158 has the lecture course PHY-108 as either a pre-requisite or a co-requisite. (Additionally, a pre-requisite for the PHY 108 lecture is PHY-107). The PHY 158 laboratory deals with related topics to those covered in the PHY 107 and PHY 108 lectures. However PHY 158 is separate from those lectures. Registration for PHY 108 lecture does not automatically register you for the PHY 158 lab and vice versa.

### **PHY 207 General Physics III**

Credits: 4

Semester: Sp

Prerequisites: PHY 107-PHY 108

Corequisites: MTH 241

Type: LEC

Repeatable: No

Note: None

Examines sound waves, electromagnetic waves, and geometrical and physical optics. Introduces modern physics, including discovery of the electron, the photon, wave-particle duality, the Bohr model of H-atom, the Schrödinger equation, quantum numbers, the Pauli principle and periodic table, and lasers.

### **PHY 208 General Physics IV**

Credits: 3

Semester: F

Prerequisites: PHY 107, PHY108

Corequisites: MTH 306

Type: LEC

Repeatable: No

Note: None

Examines thermodynamics, including temperature, zeroth law, thermal expansion, specific heat, first law, second law, entropy, third law, kinetic theory, Brownian motion, and the ideal gas. Also explores special relativity, including historical background, Lorentz transformations, length contraction, time dilation, invariance of the laws of physics, relativistic dynamics and kinematics, and paradoxes.

### **PHY 217 Honors Physics III**

Credits: 3

Semester: Sp

Prerequisites: PHY 107 and PHY 108, or PHY 117 and PHY 118

Corequisites: MTH 241

Type: LEC

Repeatable: No

Note: None

Covers the same topics as PHY 207, but in greater depth. Class size is limited. In general, taken by students in the University Honors Program, but other students may take it with permission of instructor.

### **PHY 257 General Physics III Lab**



Credits: 1  
Semester: Sp  
Prerequisites: PHY 107 and PHY 108/PHY 158,  
or PHY 117 and PHY 118/PHY 158  
Corequisites: PHY 207  
Type: LAB  
Repeatable: No  
Note: None  
Conducts experiments on waves, geometrical  
and physical optics, and modern physics.

### **PHY 286 Maple in Physics**

Credits: 1  
Semester:  
Prerequisites: PHY 107-PHY 108  
Corequisites: None  
Type: LAB  
Repeatable: No  
Note: None  
Introduces basic syntax and capabilities of this  
computer calculus/algebra system as applied  
to obtain analytical solutions to problems in  
physics. Students taking PHY386 learn the  
same syntax as PHY 286 students, but are  
required to do more advanced problems such  
as occur in junior-senior physics courses. A  
student may receive academic credit for only  
one of the two courses.

### **PHY 301 Intermediate Mechanics I**

Credits: 3  
Semester: F  
Prerequisites: PHY 107 and MTH 306  
Corequisites: None  
Type: LEC  
Repeatable: No  
Note: None  
Covers vector calculus, kinematics, studies of  
rigid bodies and cables, the virtual work  
principle, damped and forced harmonic  
oscillators, dynamics of systems of particles,  
conservation laws, and dynamics of rigid  
bodies in planar motion.

### **PHY 302 Intermediate Mechanics II**

Credits: 3  
Semester: Sp  
Prerequisites: PHY 301

Corequisites: None  
Type: LEC  
Repeatable: No  
Note: None  
Studies accelerated frames of reference,  
central force motion, scattering problems,  
D'Alembert's principle, Lagrange's equation,  
Hamilton's principle, eigenvalue problems,  
dynamics of rigid bodies, coupled harmonic  
oscillators, and normal modes of vibration.

### **PHY 307 Modern Physics Lab**

Credits: 2  
Semester: Sp  
Prerequisites: PHY 207 or PHY 217; PHY 208,  
PHY 257  
Corequisites: None  
Type: LAB  
Repeatable: No  
Note: None  
Conducts experiments in thermodynamics  
and modern physics.

### **PHY 311 Applied Acoustics of Music**

Credits: 3  
Semester:  
Prerequisites: None  
Corequisites: None  
Type: LEC  
Repeatable: No  
Note: None  
A general, practical course. Covers the  
nature of sound; the ear and the hearing  
process; consonance and dissonance; scales  
and harmonic series; basic physics of musical  
instruments; high fidelity systems; and  
theatre, studio, and room acoustics.

### **PHY 386 Maple in Physics**

Credits: 1  
Semester: Sp  
Prerequisites: PHY 107, PHY 108, PHY 207,  
PHY 208, and junior standing  
Corequisites: None  
Type: LAB  
Repeatable: No  
Note: None  
Introduces basic syntax and capabilities of

the computer calculus/algebra system as applied to obtain analytical solutions to problems in physics. Students taking PHY 386 learn the same syntax as PHY 286 students, but are required to do more advanced problems such as occur in junior-senior physics courses. A student may receive academic credit for only one of the two courses.

### **PHY 401 Quantum Mechanics I**

Credits: 3

Semester: F

Prerequisites: MTH 306, PHY 207, PHY 208

Corequisites: None

Type: LEC

Repeatable: No

Note: It is strongly recommended that physics majors take PHY 401-PHY 402 in the junior year, as these courses provide the necessary background for PHY 406, PHY 407-PHY 408, PHY 410-PHY 411, PHY 412, and PHY 527-PHY 528.

Origins of quantum theory; wave function and uncertainty principle; Schrödinger equation; one-dimensional examples; formalism of quantum mechanics.

### **PHY 402 Quantum Mechanics II**

Credits: 3

Semester: Sp

Prerequisites: PHY 401

Corequisites: None

Type: LEC

Repeatable: No

Note: None

Angular momentum; three-dimensional problems; hydrogen atom; time-independent perturbation theory; electron spin and fine structure; time-dependent perturbation theory; quantum statistics.

### **PHY 403 Electricity and Magnetism I**

Credits: 3

Semester: F

Prerequisites: MTH 241, MTH 306, PHY 108

Corequisites: None

Type: LEC

Repeatable: No

Note: None

Examines vector calculus, Gauss' law, scalar and vector potentials, Laplace and Poisson's equations, dielectrics, electrostatic and magnetostatic fields, Ampere's law, Faraday's law, and Maxwell's equations.

### **PHY 404 Electricity and Magnetism II**

Credits: 3

Semester: Sp

Prerequisites: PHY 403

Corequisites: None

Type: LEC

Repeatable: No

Note: None

Undertakes further study of Maxwell's equations, electric and magnetic susceptibilities, electromagnetic radiation, electromagnetic fields from a moving charge, waveguides and transmission lines, Poynting's vector, and Lorentz force. Also examines relativistic invariance.

### **PHY 405 Thermal and Statistical Physics I**

Credits: 3

Semester: F

Prerequisites: MTH 306, PHY 208, PHY 301

Corequisites: None

Type: LEC

Repeatable: No

Note: None

Explores statistics and statistical description of particles; statistical and macroscopic thermodynamics; basic results of classical statistical mechanics and connections with thermodynamics; microcanonical, canonical, and grand canonical ensembles; applications to ideal gases, paramagnets, and lattice vibrations; kinetic theory; and phase equilibrium of one-component systems.

### **PHY 406 Thermal and Statistical Physics II**

Credits: 3

Semester: Sp

Prerequisites: PHY 207 or PHY 217; PHY 401, PHY 405

Corequisites: None

Type: LEC

Repeatable: No

Note: None

Critical behavior at continuous phase transitions. Quantum statistics of ideal Bose and Fermi systems, applications to electrons in metals, blackbody radiation, Bose condensation, neutron stars, interacting systems, lattice vibrations, nonideal gases, ferromagnets, kinetic theory of transport processes, irreversible processes, and fluctuations.

### **PHY 407 Advanced Laboratory**

Credits: 3

Semester: F

Prerequisites: PHY 207 or PHY 217; PHY 307, PHY 401

Corequisites: None

Type: LAB

Repeatable: Yes

Note: None

Covers modern physics, with a choice of experiments: atomic physics, modern laser optics, solid state, magnetic resonance, X-ray diffraction, scanning probe microscopy, nuclear, or particle physics. Two four-hour labs each week.

### **PHY 408 Advanced Laboratory**

Credits: 3

Semester: Sp

Prerequisites: PHY 207 or PHY 217; PHY 307, PHY 401

Corequisites: None

Type: LAB

Repeatable: Yes

Note: None

Covers modern physics, with a choice of experiments: atomic physics, modern laser optics, solid state, magnetic resonance, X-ray diffraction, scanning probe microscopy, nuclear, or particle physics. Two four-hour labs each week.

### **PHY 410 Computational Physics I**

Credits: 3

Semester: usually F, but may be S

Prerequisites: PHY 207 or PHY 217; PHY 401

Corequisites: None

Type: LEC

Repeatable: No

Note: None

Examines numerical solutions of problems in dynamics, electrodynamics, and quantum and statistical physics. Also examines root-finding, numerical differentiation, quadrature, matrix inversion, and ordinary differential equations. Studies structured programming in FORTRAN 90, C++, or Java; and explores Computer graphics.

### **PHY 411 Computational Physics II**

Credits: 3

Semester: Sp

Prerequisites: PHY 410

Corequisites: None

Type: LEC

Repeatable: No

Note: None

More advanced physics problems involving partial differential equations. Numerical simulation and Monte Carlo methods, data analysis and fast Fourier transforms, use of mathematical library routines and computer algebra programs.

### **PHY 412 Nuclear and Particle Physics**

Credits: 3

Semester: Sp

Prerequisites: PHY 401

Corequisites: None

Type: LEC

Repeatable: No

Note: None

Explores fundamentals of nuclear physics, including interaction of radiation with matter; properties of nuclear forces; nuclear structure described by shell and collective models; nuclear reactions; radioactive decay processes; and properties of elementary particles.

### **PHY 413 Electronics**

Credits: 3

Semester: Sp

Prerequisites: PHY 108 or permission of

instructor  
Corequisites: None  
Type: LEC/LAB  
Repeatable: No  
Note: None  
Introduces basic concepts of circuit design, impedance, and feedback systems; solid-state components; integrated circuits; digital circuits; and basic instrumentation.

### **PHY 414 Experimental Techniques**

Credits: 2 - 3  
Semester: F  
Prerequisites: permission of instructor  
Corequisites: None  
Type: TUT  
Repeatable: No  
Note: None  
Involves individual work with faculty in a research laboratory.

### **PHY 415 Experimental Techniques**

Credits: 2 - 3  
Semester: Sp  
Prerequisites: permission of instructor  
Corequisites: None  
Type: TUT  
Repeatable: No  
Note: None  
Involves individual work with faculty in a research laboratory.

### **PHY 425 Intermediate Optics**

Credits: 3  
Semester: Sp  
Prerequisites: PHY 207 or PHY 217  
Corequisites: None  
Type: LEC  
Repeatable: No  
Note: None  
Examines geometrical and physical optics. Explores diffraction, interference, polarization, and other wave properties of light; and the quantum nature of light and lasers.

### **PHY 431 Introduction to Mathematical Physics 1**

Credits: 3  
Semester: F  
Prerequisites: MTH 417, 418  
Corequisites: None  
Type: LEC  
Repeatable: No  
Note: None

This course covers fundamentals of Mathematical Physics. It includes the following topics: linear algebra, multiple integrals, Fourier series and transforms, Calculus of variation, Special functions, and Partial Differential Equations. All topics are covered in the context of specific application and problem solving in Classical Mechanics, Quantum Mechanics, Electrodynamics and Fluid Dynamics.

### **PHY 434 Solid State Physics**

Credits: 3  
Semester: Sp  
Prerequisites: PHY 401, 405  
Corequisites: None  
Type: LEC  
Repeatable: No  
Notes: None

A one semester undergraduate introductory course in solid state physics that covers the following topics: crystal structures, diffraction of waves by crystals, crystal bonding, phonons in crystals, thermal properties of phonons, free electron Fermi gas, energy bands in crystals, semiconductor crystals, optical properties, devices, magnetism, nanostructures.

### **PHY 480 Special Topics in Physics**

Credits: 1-3  
Semester: F Sp  
Prerequisites: None  
Corequisites: None  
Type: LEC  
Repeatable: Yes  
Note: None  
From time to time courses will be offered on topics not covered in regularly offered physics courses.

**PHY 497 Honors**

Credits: 3

Semester: F Sp

Prerequisites: None

Corequisites: None

Type: TUT

Repeatable: No

Note: None

For students who wish to do a senior thesis. Consult the Undergraduate Director, Professor Cerne, for details.

**PHY 498 Undergraduate Research**

Credits: 1 - 3

Semester: F Sp

Prerequisites: None

Corequisites: None

Type: TUT

Repeatable: Yes

Note: None

This course allows students to get credit for research activities carried out under the supervision of a faculty member of the Department of Physics.

**PHY 499 Independent Study in Physics**

Credits: 1 - 4

Semester: F Sp

Prerequisites: None

Corequisites: None

Type: TUT

Repeatable: Yes

Note: None

Involves individual study arranged between a student and a faculty member. Not restricted to students with professional goals in technical areas.