

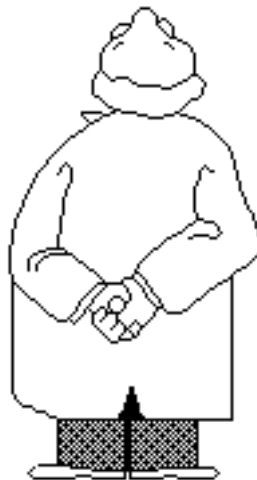


University at Buffalo
State University of New York

Undergraduate Handbook

Department Of Physics

2008-2009

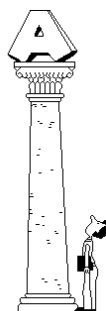


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I. GENERAL INFORMATION

Physics is the fundamental science underlying the investigation of all natural phenomena. It has provided much of the theory and many of the experimental techniques that are widely used in present day science and technology. The list of developments that have come directly from physics is rather impressive: solid state electronics, lasers; the nuclear magnetic resonance techniques used in biology, chemistry and medicine; x-ray crystallography; electron microscopy; superconductivity; etc. Physics has also provided a stimulus to philosophy and the general development of the ideas that seek to explain our relation to the rest of the universe.

The Department of Physics is housed in Fronczak Hall and consists of 22 full-time faculty members, an administrative assistant, three 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.

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 the Teaching of Science*, 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 Section VI.

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

For general information about the programs in Physics it is best to consult with the Undergraduate Director for Physics, Professor H. Luo [126 Fronczak Hall, (716) 645-2017 ext 120, e-mail: luo@buffalo.edu]. The best way to contact him is by e-mail.

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. 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 file an *Application for Degree* form with the Student Response Center (232 Capen). The form is available at <http://src.buffalo.edu/forms/additionalstudentforms.shtml>. Applications for June 1, September 1, and February 1 graduations must be filed by February 1, July 1, and October 1, 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. H. Luo). The procedure for applying to each program is given in Section VI.

The *B.S. in Physics* is designed for the student considering a professional career as a physicist. This degree is strongly recommended for students planning to continue their education in graduate school at the M.S. or Ph.D. level. It is also recommended for students who wish to obtain industrial employment in research and development, or in a government laboratory.

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 wish to continue in such areas as geophysics, biophysics, science and public policy, and high school teaching; 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 the Teaching of Science* provides the background in physics and mathematics necessary to do an outstanding job of teaching physics at the high school level. It is not appropriate for students who wish to do graduate work in physics, but it is appropriate for graduate work 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 co-administered by the Department of Mathematics and the Department of Physics. It is designed for students who wish to pursue careers in applied mathematics or theoretical physics. The *Engineering Physics* program is co-administered by the Department of Electrical Engineering and the Department of Physics. It is designed for students whose interests center on the more fundamental areas of engineering and physics, but who also seek additional contact with applied aspects of these subjects. 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, 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 designed for students who are interested in applying computer based techniques to solving research problems in physics, or who wish to develop software for use in research and/or in the teaching of physics. The program is such that

students can pursue an advanced degree in physics or computer science. As pointed out above, it is 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.

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 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 406 Thermal and Statistical Physics II

PHY 407 Advanced Laboratory

PHY 408 Advanced Laboratory

One PHY elective (one of the following: PHY 310 Intermediate Optics, PHY 410 Computational Physics I, PHY 412 Nuclear and Particle Physics, or PHY 413 Electronics)

Note: Technical electives outside of the department may be substituted for the PHY elective upon approval of the Undergraduate Director for the Department of Physics.

Note: Other lab courses may be substituted for CHE 101–102 upon approval of the Undergraduate Director for the Department of Physics.

RECOMMENDED SEQUENCE FOR BS IN PHYSICS MAJOR REQUIREMENTS

First Year

CHE 101 General Chemistry (F)	PHY 107 General Physics I or PHY 117 Honors Physics I (Sp)
MTH 141 College Calculus I (F)	MTH 142 College Calculus II (Sp)
	CHE 102 General Chemistry (Sp)

Second Year

PHY 108 General Physics II or PHY 118 Honors Physics II (F)	PHY 207 General Physics III or PHY 217 Honors Physics III (Sp)
PHY 158 General Physics II Lab (F)	PHY 257 General Physics III Lab (Sp)
MTH 241 College Calculus III (F)	PHY 208 General Physics IV (Sp)
	MTH 306 Intro to Differential Equations (Sp)

Third Year

PHY 301 Intermediate Mechanics I (F)	PHY 302 Intermediate Mechanics II (Sp)
PHY 307 Modern Physics Lab (F)	
PHY 401 Modern Physics I (F)	PHY 402 Modern Physics II (Sp)
MTH 417 Survey of Multivariable Calculus (F)	MTH 418 Survey of Partial Differential Eqns. (Sp)

Fourth Year

PHY 403 Electricity and Magnetism I (F)	PHY 404 Electricity and Magnetism II (Sp)
PHY 405 Thermal and Statistical Physics I (F)	PHY 406 Thermal and Statistical Physics II (Sp)
PHY 407 Advanced Laboratory (F)	PHY 408 Advanced Laboratory (Sp)
PHY elective (F or Sp)	

SUMMARY

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

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 Modern Physics I

PHY 402 Modern Physics II

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 310 Intermediate Optics, PHY 404 Electricity and Magnetism II, PHY 410 Computational Physics I, PHY 413 Electronics)

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

Note: Other lab courses may be substituted for CHE 101-102 upon approval of the Undergraduate Director for the Department of Physics.

RECOMMENDED SEQUENCE FOR BA IN PHYSICS MAJOR REQUIREMENTS

First Year

CHE 101 General Chemistry (F)	CHE 102 General Chemistry (Sp)
MTH 141 College Calculus I (F)	MTH 142 College Calculus II (Sp)
	PHY 107 General Physics I or PHY 117 Honors Physics I (Sp)

Second Year

MTH 241 College Calculus III (F)	MTH 306 Intro to Differential Equations (Sp)
PHY 108 General Physics II or PHY 118 Honors Physics II (F)	PHY 207 General Physics III or PHY 217 Honors Physics III (Sp)
PHY 158 General Physics II Lab (F)	PHY 257 General Physics III Lab (Sp)
	PHY 208 General Physics IV (Sp)

Third Year

PHY 301 Intermediate Mechanics I (F)	PHY Elective
PHY 307 Modern Physics Lab (F)	
PHY 401 Modern Physics I (F)	PHY 402 Modern Physics II (Sp)

Fourth Year

PHY 403 Electricity and Magnetism I (F)	PHY Elective
PHY 405 Thermal and Statistical Physics I (F)	PHY Elective
PHY 407 Advanced Laboratory (F)	or PHY 408 Advanced Laboratory (Sp)

SUMMARY

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

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

MTH 141 College Calculus I (F)	PHY 107 General Physics I or PHY 117 Honors Physics I (Sp)
	MTH 142 College Calculus II (Sp)

Second Year

PHY 108 General Physics II or PHY 118 Honors Physics II (F)	PHY 207 General Physics III or PHY 217 Honors Physics III (Sp)
PHY 158 General Physics II Lab (F)	PHY 208 General Physics IV (Sp)

Third Year

PHY 301 Intermediate Mechanics I (F)	
PHY Elective	

Fourth Year

PHY 403 Electricity and Magnetism I (F)	
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SUMMARY

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

TEACHING OF SCIENCE-B.A.

Students pursuing this program must also pursue the Undergraduate Minor in Education, which is administered by the Teacher Education Institution (TEI). Applications to the minor must be filed with the TEI office in 375 Baldy Hall. Applications must include a UB DARS report and/or official transcripts from all other institutions attended other than UB. These concentrations are designed for the student whose career goal is to attain a master's degree for professional certification in science education. 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 Teacher Education Institute (TEI), 375 Baldy Hall. Completion of the major concentration (including the required education courses) provides advanced status toward initial New York State teacher certification, accomplished through one year of subsequent coursework at the graduate level through the Graduate School of Education. It is then possible to complete, within the state-mandated three years, the master's degree required for a professional teaching certificate, provided all NYS requirements have been successfully completed.

Acceptance Criteria for Physics: GPA of 2.0 in MTH 141-142, PHY 107-108/158. TEI requires a minimum 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

CHE 101 General Chemistry (F)	CHE 102 General Chemistry (Sp)
MTH 141 College Calculus I (F)	MTH 142 College Calculus II (Sp)
	PHY 107 General Physics I or PHY 117 Honors Physics I (Sp)

Second Year

MTH 241 College Calculus III (F)	MTH 306 Intro to Differential Equations (Sp)
PHY 108 General Physics II or PHY 118 Honors Physics II (F)	PHY 207 General Physics III or PHY 217 Honors Physics III (Sp) PHY 257 General Physics III Lab
PHY 158 General Physics II Lab (F)	PHY 208 General Physics IV (Sp)

Third Year

PHY 307 Modern Physics Lab (F)	
PHY Elective	PHY Elective

Fourth Year

PHY Elective	PHY Elective
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SUMMARY

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

TEACHING OF - 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 257 General Physics III Lab
PHY 208 General Physics IV
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

CHE 101 General Chemistry (F)	CHE 102 General Chemistry (SP)
MTH 141 College Calculus I (F)	MTH 142 College Calculus II (Sp)
	PHY 107 General Physics I or PHY 117 Honors Physics I (Sp)

Second Year

MTH 241 College Calculus III (F)	MTH 306 Intro to Differential Equations (Sp)
PHY 108 General Physics II or PHY 118 Honors Physics II (F)	PHY 207 General Physics III or PHY 217 Honors Physics III (Sp) PHY 257 General Physics III Lab
PHY 158 General Physics II Lab (F)	PHY 208 General Physics IV (Sp)

Third Year

CHE 201 Organic Chemistry (F)	CHE 202 Organic Chemistry (Sp)
CHE 214 Introduction to Analytical Chemistry (F)	
PHY 307 Modern Physics Lab (F)	

Fourth Year

PHY Elective (F)	PHY Elective (Sp)
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SUMMARY

Total required credit hours in chemistry, mathematics, and physics	64
Total required credit hours in education	19
General education courses and electives	37
Total required credit hours	120

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 Algebra I

MTH 424 Fourier Series

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 Modern Physics I

PHY 403 Electricity and Magnetism I

PHY 405 Thermal and Statistical Physics I

PHY 407 or PHY 408 Advanced Laboratory

One PHY elective (one of the following: PHY 302 Intermediate Mechanics II, PHY 402 Modern Physics 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

MTH 141 College Calculus I (F)	MTH 142 College Calculus II (Sp)
	PHY 107 General Physics I or PHY 117 Honors Physics I (Sp)

Second Year

MTH 241 College Calculus III (F)	MTH 306 Introduction to Differential Equations (Sp)
PHY 108 General Physics II or PHY 118 Honors Physics II (F)	MTH 309 Introductory Linear Algebra (Sp)
PHY 158 General Physics II Lab (F)	PHY 207 General Physics III or PHY 217 Honors Physics III (Sp)
	PHY 208 General Physics III (Sp)
	PHY 257 General Physics III Lab (Sp)

Third Year

MTH 417 Survey of Multivariable Calculus (F)	MTH 418 Survey of Partial Differential Eqns. (Sp)
PHY 301 Intermediate Mechanics I (F)	PHY Elective
PHY 307 Modern Physics Lab (F)	
PHY 401 Modern Physics I (F)	

Fourth Year

MTH 419 Introduction to Algebra I (F)	MTH 424 Fourier Series (Sp)
MTH 425 Introduction to Complex Variables I (F)	MTH Elective
PHY 403 Electricity and Magnetism I (F)	PHY 408 Advanced Laboratory (Sp)
PHY 405 Thermal and Statistical Physics I (F)	

SUMMARY

Total required credit hours in mathematics and physics	81
General education courses and electives	39
Total required credit hours	120

ENGINEERING PHYSICS–B.S.

Acceptance Criteria: Admission to this program will be made after completion of the first two semesters. 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 107-108/158, 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).

REQUIRED COURSES

CHE 107 General Chemistry for Engineers
CHE 108 General Chemistry for Engineers
EAS 140 Engineering Solutions
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

CHE 107 General Chemistry for Engineers (F)	CHE 108 General Chemistry for Engineers (Sp)
EAS 140 Engineering Solutions (F)	MTH 142 College Calculus II (Sp)
MTH 141 College Calculus I (F)	PHY 107 General Physics I or PHY 117 Honors Physics I (Sp)

Second Year

EE 202 Circuit Analysis I (F)	EAS 230 Higher-Level Language (Sp)
MTH 241 College Calculus III (F)	MTH 306 Introduction to Differential Eqns. (Sp)
PHY 108 General Physics II or PHY 118 Honors Physics II (F)	PHY 207 General Physics III or PHY 217 Honors Physics III (Sp)
PHY 158 General Physics II Lab (F)	PHY 257 General Physics III Lab (Sp)
	PHY 208 General Physics IV (Sp)
	Technical Elective

Third Year

EE 310 Electronic Devices and Circuits I (F)	EE 311 Electronic Devices and Circuits II (Sp)
EE 352 Introduction to Electronics Lab (F)	EE 353 Electronic Circuits Lab (Sp)
PHY 301 Intermediate Mechanics I (F)	MTH 418 Survey of Partial Differential Eqns. (Sp)
PHY 307 Modern Physics Lab (F)	
PHY 401 Modern Physics I (F)	PHY 402 Modern Physics II (Sp)

Fourth Year

EE 410 Electronic Instrument Design I (F)	MAE 335 Fluid Mechanics (Sp)
MTH 417 Survey of Multivariable Calculus (F)	PHY 404 Electricity and Magnetism II (Sp)
PHY 403 Electricity and Magnetism I (F)	Technical Elective
PHY 405 Thermal and Statistical Physics I (F)	Technical Elective
PHY 407 Advanced Laboratory (F)	or PHY 408 Advanced Laboratory (Sp)

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 492, EE 494, EE 439 (the laser-quantum

electronics engineering optics sequence) PHY 310 Intermediate Optics, PHY 406 Thermal and Statistical Physics II, PHY 407–408 Advanced Laboratory.

SUMMARY

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

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 Modern Physics I
PHY 403 Electricity and Magnetism I
PHY 405 Thermal and Statistical Physics I
PHY 407 Advanced Laboratory or PHY 408 Advanced Laboratory
Elective (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

CSE 115 Introduction to Computer Science for Majors I (F)	CSE 116 Introduction to Computer Science for Majors II (Sp)
MTH 141 College Calculus I (F)	MTH 142 College Calculus II (Sp)
	PHY 107 General Physics I or PHY 117 Honors Physics I (Sp)

Second Year

CSE/MTH 191 Introduction to Discrete Mathematics (F)	CSE 250 Algorithms and Data Structures (Sp)
MTH 241 College Calculus III (F)	MTH 306 Intro to Differential Equations (Sp)
PHY 108 General Physics II or PHY 118 Honors Physics II (F)	PHY 207 General Physics III or PHY 217 Honors Physics III (Sp)
PHY 158 General Physics II Lab (F)	PHY 257 General Physics III Lab (Sp)
	PHY 208 General Physics IV (Sp)

Third Year

CSE 305 Intro to Programming Languages (F)	CSE 442 Software Engineering(Sp)
PHY 301 Intermediate Mechanics I (F)	MTH 309 Introductory Linear Algebra (Sp)
PHY 307 Modern Physics Lab (F)	
PHY 401 Modern Physics I (F)	PHY 407 or 408 Advanced Laboratory (Sp)

Fourth Year

PHY 403 Electricity and Magnetism I (F)	
PHY 405 Thermal and Statistical Physics I (F)	Elective
CSE/MTH 437 Introduction to Numerical Analysis I or PHY 410 Computational Physics I (F)	CSE/MTH 438 Introduction to Numerical Analysis II or PHY 411 Computational Physics II (Sp)

SUMMARY

Total required credit hours in computer science, mathematics, and physics	87-90
General education courses and electives	30-33
Total required credit hours	117-123

5 YEAR BS IN COMPUTATIONAL PHYSICS / MS IN PHYSICS

ACCEPTANCE CRITERIA

Minimum GPA of 3.0 in CSE 115-116, CSE/MTH119, 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 Modern Physics I

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

CSE 115 Introduction to Computer Science for Majors I (F)	CSE 116 Introduction to Computer Science for Majors II (Sp)
MTH 141 College Calculus I (F)	MTH 142 College Calculus II (Sp)
	PHY 107 General Physics I or PHY 117 Honors Physics I (Sp)

Second Year

CSE/MTH 191 Introduction to Discrete Mathematics (F)	CSE 250 Algorithms and Data Structures (Sp)
MTH 241 College Calculus III (F)	MTH 306 Intro to Differential Equations (Sp)
PHY 108 General Physics II or PHY 118 Honors Physics II (F)	PHY 207 General Physics III or PHY 217 Honors Physics III (Sp)
PHY 158 General Physics II Lab (F)	PHY 207 General Physics III Lab (Sp)
	PHY 208 General Physics IV (Sp)

Third Year

CSE 305 Intro to Programming Languages (F)	MTH 309 Introductory Linear Algebra (Sp)
PHY 301 Intermediate Mechanics I (F)	Elective (Calculus-based probability/statistics course) (Sp)
PHY 307 Modern Physics Lab (F)	
PHY 401 Modern Physics I (F)	

Fourth Year

CSE 442 Software Engineering (F)	PHY 506 Computational Physics II (Sp)
PHY 403 Electricity and Magnetism I (F)	PHY 552 Graduate Lab (Sp)
PHY 405 Thermal and Statistical Physics I (F)	
PHY 505 Computational Physics I (F)	

Fifth Year

PHY 515 High Performance Scientific Computing I (F)	PHY 516 High Performance Scientific Computing I (Sp)
PHY 500 Elective (F)	PHY 500 Elective (Sp)
PHY 500 Elective (F)	PHY 500 Elective (Sp)

SUMMARY

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

IV. GENERAL EDUCATION REQUIREMENTS

For Freshmen and Transfer Students Who Enter Fall 2002

Writing

Complete ENG101 and ENG201, or ENG102, as placed, unless exempted.

Library Skills

Complete the Library Skills Workbook at <http://ublib.buffalo.edu/libraries/workbook>.

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

CSE 112 Great Ideas in Computer Science II

STA 111 Introduction to Statistics I

ADDITIONAL COURSES THAT SATISFY THE MATHEMATICAL SCIENCES REQUIREMENT

CEP 207 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 114 Introduction to Computer Science II

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 I

CSE/MTH 192 Introduction to Discrete Mathematics II

MTH 115 or ULC 148 Survey of Algebra and Trigonometry

MTH 121 or MTH 131 or MTH 141 or MTH 151 or MTH 153*

MTH 122 or MTH 132 or MTH 142 or MTH 152 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 111-112 World Civilizations I-II.

Natural Sciences

Complete a two-course sequence from the following lists.

RECOMMENDED COURSE SEQUENCES FOR STUDENTS WHO ARE NOT MEETING A SPECIFIC REQUIREMENT OF A MAJOR

BIO 129–130 Perspectives in Human Biology

GEO 101 and 106 Physical Environmental Geography

GLY 101–102 Global Environmental Science

NTR 108–NTR109/NTR 110 Human Nutrition/Nutrition in Practice

PHY 121–122 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–CHE 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: Architecture majors only complete ARC352 and PHY101; Nursing and OT majors only complete ANA113 and PGY300.

American Pluralism or Cognate (approved equivalent courses)

Complete UGC 211 American Pluralism and the Search for Equality or any one of the following: ARC 211, AHI 390, DMS 213, HIS 161, HIS 162, LIN 200, SOC 211.

Note: UGC 111-112 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.

Except:

Courses used to satisfy any other general education requirement are excluded

Language Requirement

Complete second-semester course or proficiency in a language other than English equivalent to completion of a second-semester course (e.g., SPA 102/FR 102/ LAT 102 or SPA 104/FR 104/LAT 104.) Students continuing their high school language will ordinarily take one additional semester of language study. Students beginning a new language will ordinarily take two semesters of language study.

Students may demonstrate proficiency in a language other than English by:

1. Completing a second-semester course (e.g. SPA 102 or SPA 104); or
2. Achieving a minimum score of 600 on a College Board Foreign Language Achievement Test; or
3. Achieving a minimum score of 3 or 4 (depending upon the language and the test) on an AP test in a foreign language; or
4. Showing a high school diploma from a country whose language of instruction is other than English; or
5. Passing a "challenge examination" administered by the Department of Modern Languages and Literatures.

Note: Majors in the following schools and programs are not required to complete language study: Architecture, Environmental Design; Engineering; Public Health and Health Professions; Management; Nursing; Pharmacy; B.F.A. in Art, Dance, Music Theatre, Theatre; MusB. in Music; Biochemical Pharmacology, Medicinal Chemistry; Pharmaceuticals.

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

Humanities

Students completing ENG 101/ENG 201 have met this requirement. Students completing ENG 102 must complete one 3-credit course offered from AAS, AMS, CL, COL, ENG (excluding ENG 101/ENG 201), FR, GER, HIS, ITA, PHI, RSP, SPA, WLP, WS, and other languages.

EXCEPT:

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; ARC 121 is also an option.

EXCEPT:

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 303 Great Discoveries in Science
- A natural sciences course numbered 200 or higher
- Any one of the following courses:
APY 310, 328, 338, 344, 345, 348, 350;
ARC 442;
CDS 288, 382;
GEO 345, 347, 348, 350, 352, 356, 435; 449;
PSY 230, 402, 434, 435, 436, 439

EXCEPT:

Courses used to satisfy any other general education requirement are excluded

Advising Notes

S/U grading is not an option in any course used to satisfy these 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. Each course may be applied toward only one general education requirement.

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 Luo, before doing so. 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 PHY 401 before taking *Advanced Lab* (PHY 407, 408), *Nuclear and Particle Physics* (PHY 412), or *Solid State Physics* (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 Luo, on a regular basis so as to make sure that you are fulfilling the General Education Requirements. Engineering Physics students should also consult with a SEAS Advisor in 410 Bonner Hall. For complicated problems arising in connection with General Education it is best to consult with Ms. Pamela Wendling, Director, Natural Sciences Services (pwendlin@buffalo.edu, 645–6883 ext. 278, 275 Park Hall). She is on the staff of the Dean of the College of Arts and Sciences.

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

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 Luo. Simply inform him of your intended major and he will take it from there. 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. Professors Luo and Bird are the Co-Chairs for this program.

Upon being accepted into a degree program, the student will receive a letter or e-mail confirming the acceptance. The Department of Physics creates a file for each student accepted into one of its programs. Once accepted be sure to check with the Undergraduate Director (H. Luo) at least once a semester before registering for the following semester.

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 Undergraduate Studies Committee.

Those students who successfully complete the Physics Honors Program will receive

recognition at graduation. The designations *Honors*, *High Honors* or *Highest Honors* will appear on the student's diploma, and awards will be given at the reception held each year for the BA and BS recipients of the Department of Physics.

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

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/crssprgm/reu/reu_search.cfm. 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.

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
P.O. Box 6000
Princeton, N.J. 08541-6000

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

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 Dr. Josephine Capuana, Administrative Director of the University Honors Program (214 Talbert Hall). 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)



APPENDIX A.

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

APPENDIX B.

COURSE DESCRIPTIONS

PHY 100 Introduction to Physics

Credits: 1
Semester: F Sp
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.

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.

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.

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.

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: None
Corequisites: MTH 141
Type: LEC/REC
Repeatable: No
Note: None

Covers the same topics as PHY 107, 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 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

Covers the same topics as PHY108, 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 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

An introduction to astronomy, covering scales in the universe, constellations and the night sky, the history of astronomy from ancient times to the present, astronomical instrumentation, spectroscopy, the birth and evolution of stars, white dwarfs, neutron stars, and black holes.

PHY 122 Descriptive Astronomy II

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

A continuation of PHY121, covering the Milky Way Galaxy, other galaxies in the universe, cosmology and the origin of the universe, the formation of the solar system, earthlike planets, planets of the outer solar system, meteorites, asteroids, and comets. The theme of the class is origins: How did the universe begin? What was the origin of the earth? How did life begin?

PHY 151 College Physics I Lab

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

Studies mechanics, heat, waves, and sound.

PHY 152 College Physics II Lab

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

Studies electricity and magnetism, light, optics, and modern physics.

PHY 158 General Physics II Lab

Credits: 1
Semester: F Sp
Prerequisites: PHY 107
Corequisites: PHY 108
Type: LAB

Repeatable: No
Note: None

Conducts experiments on mechanics, as well as electricity and magnetism.

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: Sp
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: F
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 310 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 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 Modern Physics 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 Modern Physics 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 208, PHY 257, 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 208, PHY 257, 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: F
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 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 Luo, 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.