University at Buffalo
State University of New York

Undergraduate Handbook

Department of Physics

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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 humankind.

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: 1) basic laws of physics, 2) critical thinking and problem-solving skills, 3) laboratory skills, 4) contemporary areas of physics, and 5) 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.

The Department of Physics offers a *BS, BA,* and a *Minor in Physics*; and participates in the interdisciplinary programs which lead to a *BA in Physics with Teaching of Science Concentration,* a *BS in Computational Physics*, a *BS in Mathematical Physics,* and a *BS in Engineering Physics*. We also offer combined bachelors/masters 5-year programs leading to a *BS in Computational Physics/M.S. in Physics*, *BA in Physics – Teaching of Science Physics Concentration/Physics Adolescent Education EdM*, and *BA in Physics – Teaching of Science Physics and Chemistry/Physics Adolescent Education EdM*. The required courses and the recommended sequence for each program are given in Section III. The *UB Curriculum* requirements that apply to the various programs are summarized in Section IV, while general guidelines for all the programs are presented in Section V.

Although newly matriculated freshmen are directly admitted into any of the above programs, they must maintain the acceptance GPA requirements in the pre-requisite courses that are listed in Section III to continue in the program. In addition to the GPA requirements, students admitted directly to the Physics major must earn a grade of C or better in the introductory Physics and Mathematics courses required for the major. Students who earn below a C must repeat the course to satisfy the major requirements. The courses only get harder and if students are not doing well in introductory courses (where they are competing with students who mostly are not majoring on physics), majoring in physics may not be a good choice for them. Please be aware that students need a 2.0 GPA in major courses as well as overall to graduate from UB. For transfer students and students who are switching majors to physics, we will apply the acceptance criteria listed in Section III. 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. Students with high GPAs in their major are also eligible to graduate with departmental distinction, which is described in Section VII. Our top students are eligible for Departmental awards and/or induction into the ΣΠΣ Physics Honor Society, which is covered by Section VIII. Undergraduate research, which plays a critical role in the development of our majors, is discussed in Section IX. Advice for students planning to do graduate work in Physics is given in Section X.

For general information about the programs in Physics it is best to consult with the Undergraduate Coordinator Ms. Mariam Ashour and/or the Undergraduate Director for Physics, Professor John Cerne. Their contact information is given on the first page of this Handbook.

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 students are close to graduation they should consult with the Undergraduate Director to make sure that all of the requirements of the Department of Physics, as well as the UB Curriculum 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. Our undergraduate plans are listed below:

The BS 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 *BA 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 *BA 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.

BA in Physics – Teaching of Science Physics Concentration/Physics Adolescent Education EdM, offers a BA in Physics with Teaching of Science Physics Concentration/Physics Adolescent Education. This degree provides the essential background in physics and mathematics necessary for teaching physics at the secondary (grades 7-12) level. This track is highly appropriate for students who wish to pursue graduate study in education; however, it is not ideal for students who wish to pursue graduate study in physics. The Physics Education program is an accelerated, combined degree program that leads to a Physics BA and Physics education EdM in five years.

The *BA in Physics – Teaching of Science Physics and Chemistry/Physics Adolescent Education EdM* and , is an accelerated, combined degree program that leads to a Physics BA and Physics education EdM in five years and focuses on preparing you to teach physics and chemistry at the adolescence level. In the first three years of the program, students will develop a deep understanding of physics and chemistry. At the same time, students will take education courses that will include experiential components to introduce the nuances of the teaching profession. At the end of both BA/EdM programs, successful students will receive recommendation for New York State Initial and Professional Teacher Certification.

The *BS 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 *BS in Computational Physics* combines requirements from the BS in Physics and the BS 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/CONTINUATION CRITERIA, AND CURRICULAR PLANS

For all of the programs described in this section students must also fulfill the requirements of the UB Curriculum Program, which are summarized in Section IV.

PHYSICS–BS

Acceptance/Continuation Criteria: GPA of 2.0 in MTH 141–142, PHY 107–108/158. We are now requiring that our majors receive Cs or better in all these courses.

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
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.

CURICULAR PLAN FOR BS IN PHYSICS MAJORS

First Year Fall
UB Seminar Credits: 3
CHE 101LR - General Chemistry Credits: 4
CHE 113LAB - General Chemistry Credits: 1
MTH 141LR - College Calculus I Credits: 4
PHY 107LR - General Physics I Credits: 4 ***OR***
PHY 117LR - Honors Physics I Credits: 4
Total Credits: 16

First Year Spring
MTH 142LR - College Calculus 2 Credits: 4
PHY 108LR - General Physics II Credits: 4 ***OR***
PHY 118LR - Honors Physics II Credits: 4
PHY 158LAB - General Physics II Lab Credits: 1
CHE 102LR - General Chemistry Credits: 4
CHE 114LAB - General Chemistry Credits: 1
ENG 105LEC - Writing and Rhetoric Credits: 4
Total Credits: 18

Second Year Fall
MTH 241LR - College Calculus 3 Credits: 4
MTH 306LR - Introduction to Differential Equations Credits: 4
PHY 208LEC-General Physics IV Credits: 3
Pathway Credits: 3
Pathway Credits: 3
Total Credits: 17

Second Year Spring
MTH 418LR - Survey of Partial Differential Equations Credits: 4
PHY 207LR - General Physics III Credits: 4
PHY 257LAB - General Physics III Lab Credits: 1
Pathway Credits: 3
Pathway Credits: 3
Total Credits: 15

Third Year Fall
MTH 417LR-Survey of Multivariable Calculus Credits: 4
PHY 301LEC - Intermediate Mechanics I Credits: 3
PHY 401LEC-Quantum Mechanics I-Fundamentals Credits: 3
Communication Literacy 2 Credits: 3
Total Credits: 13

Third Year Spring
PHY 302LEC-Intermediate Mechanics II Credits: 3
PHY 307LAB - Modern Physics Lab Credits: 2
PHY 402LEC - Quantum Mechanics II - Applications Credits: 3
Pathway Credits: 3
Pathway Credits: 3
Total Credits: 14

Fourth Year Fall
PHY 403LEC-Electricity and Magntism I Credits: 3
PHY 405LEC-Therml and Stats Physics I Credits: 3
Physics Elective Credits: 3
PHY 407LAB-Advanced Laboratory Credits: 3 ***OR***
PHY 408LAB - Advanced Lab Credits: 3
UBC 399MNT-UB Curriculum Capstone Credits: 1
Total Credits: 13

Fourth Year Spring
PHY 404LEC-Electric and Magntism II Credits: 3i
Technical Elective Credits:
Physics Elective Credits: 3
Elective Credits: 3

Elective Credits: 2 **Total Credits: 14**

SUMMARY of Credit Hours

Total required credit hours in physics	51
Total required credit hours outside physics	34
UB Curriculum courses and electives	35
Total required credit hours	120

PHYSICS–BA

Acceptance Criteria/ Continuation: GPA of 2.0 in MTH 141–142, PHY 107–108/158. We are now requiring that our majors receive Cs or better in all these courses.

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
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

CURRICULAR PLAN FOR BA IN PHYSICS MAJORS

First Year Fall
UB Seminar Credits: 3
CHE 101LR - General Chemistry Credits: 4
CHE 113LAB - General Chemistry Credits: 1
MTH 141LR - College Calculus I Credits: 4
PHY 107LR - General Physics I Credits: 4 ***OR***
PHY 117LR - Honors Physics I Credits: 4
Total Credits: 16

First Year Spring
MTH 142LR - College Calculus 2 Credits: 4
PHY 108LR - General Physics II Credits: 4 **OR**
PHY 118LR - Honors Physics II Credits: 4
PHY 158LAB - General Physics II Lab Credits: 1
CHE 102LR - General Chemistry Credits: 4
CHE 114LAB - General Chemistry Credits: 1
ENG 105LEC - Writing and Rhetoric Credits: 4
Total Credits: 18

Second Year Fall
MTH 241LR - College Calculus 3 Credits: 4
MTH 306LR - Introduction to Differential Equations Credits: 4
PHY 208LEC - General Physics IV Credits: 3
Pathway Credits: 3
Pathway Credits: 3
Total Credits: 17

Second Year Spring
PHY 207LR - General Physics III Credits: 4
PHY 257LAB - General Physics III Lab Credits: 1
Pathway Credits: 3
Pathway Credits: 3
Elective Credits: 3
Total Credits: 14

Third Year Fall
PHY 301LEC - Intermediate Mechanics I Credits: 3
PHY 401LEC - Quantum Mechanics I - Fundamentals Credits: 3
Communication Literacy 2 Credits: 3
Pathway Credits: 3
Elective Credits: 3
Total Credits: 15

Third Year Spring
PHY 307LAB - Modern Physics Lab Credits: 2
PHY 402LEC - Quantum Mechanics II - Applications Credits: 3
PHY Elective Credits: 3
Pathway Credits: 3
Elective Credits: 4
UBC 399MNT-UB Curriculum Capstone Credits: 1
Total Credits: 16

Fourth Year Fall
PHY 403LEC - Electricity and Magnetism I Credits: 3
PHY 405LEC -Thermal and Statistical Physics I Credits: 3
Physics Elective Credits: 3
Elective Credits: 3
Total Credits: 12

Fourth Year Spring
Physics 300/400 level Elective Credits: 3
PHY 408LAB-Advanced Laboratory Credits: 3 ***OR***
PHY 407LAB - Advanced Laboratory Credits: 3
Elective Credits: 3
Elective Credits: 3
Total Credits: 12

SUMMARY of Credit Hours

Total required credit hours in physics	46
Total required credit hours outside physics	26
UB Curriculum courses and electives	48
Total required credit hours	120

PHYSICS – MINOR

Acceptance Criteria/Continuation: GPA of 2.5 in MTH 141–142, PHY 107–108/158. We are now requiring that our minors receive Cs or better in all these courses.

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 (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 **or** PHY 117 Honors Physics I	PHY 108 General Physics II **or** PHY 118 Honors Physics II
	PHY 158 General Physics II Lab

Second Year

PHY 208 General Physics IV	PHY 207 General Physics III

Third Year

PHY 301 Intermediate Mechanics I	
PHY Elective	

Fourth Year

PHY 403 Electricity and Magnetism I	

SUMMARY of Credit Hours

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

PHYSICS BA - TEACHING OF SCIENCE PHYSICS CONCENTRATION

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/Continuation Criteria for Physics: GPA of 2.0 in MTH 141–142, PHY 107–108/158. We are now requiring that our majors receive Cs or better in all these courses. LAI requires a minimum overall GPA of 2.5 for admission to the minor in education.

TEACHING OF SCIENCE – PHYSICS

REQUIRED COURSES
PHY 107LR - General Physics I Credits: 4 OR
PHY 117LR - Honors Physics I Credits: 4
PHY 108LR - General Physics II Credits: 4 OR
PHY 118LR - Honors Physics II Credits: 4
PHY 158LAB - General Physics II Lab Credits: 1
PHY 207LR - General Physics III Credits: 4
PHY 208LEC - General Physics IV Credits: 3
PHY 257LAB - General Physics III Lab Credits: 1
PHY 307LAB - Modern Physics Lab Credits: 2
Four 300/400 level PHY electives (excluding PHY 497, 498, 499).
CHE 101LR - General Chemistry Credits: 4
CHE 113LAB - General Chemistry Credits: 1
CHE 102LR - General Chemistry Credits: 4
CHE 114LAB - General Chemistry Credits: 1
MTH 141LR - College Calculus I Credits: 4
MTH 142LR - College Calculus 2 Credits: 4
MTH 241LR - College Calculus 3 Credits: 4
MTH 306LR - Introduction to Differential Equations Credits: 4
CEP 400LEC - Educational Psychology Credits: 3 OR
ELP 405LEC - Sociology of Education Credits: 3
LAI 350LEC - Introduction to Education Credits: 4
Complete 11 or more credits, at least 6 credits at the 300/400 level.

CURRICULAR PLAN FOR TEACHING OF SCIENCE MAJORS

Teaching of Science – Physics

First Year Fall
UB Seminar Credits: 3
CHE 101LR - General Chemistry Credits: 4
CHE 113LAB - General Chemistry Credits: 1
MTH 141LR - College Calculus I Credits: 4
PHY 107LR - General Physics I Credits: 4 ***OR***
PHY 117LR - Honors Physics I Credits: 4
Total Credits: 16

First Year Spring
MTH 142LR - College Calculus 2 Credits: 4
PHY 108LR - General Physics II Credits: 4 ***OR***
PHY 118LR - Honors Physics II Credits: 4
PHY 158LAB - General Physics II Lab Credits: 1
CHE 102LR - General Chemistry Credits: 4
CHE 114LAB - General Chemistry Credits: 1
ENG 105LEC - Writing and Rhetoric Credits: 4
Total Credits: 18

Second Year Fall
MTH 241LR - College Calculus 3 Credits: 4
MTH 306LR - Introduction to Differential Equations Credits: 4
PHY 208LEC - General Physics IV Credits: 3
Pathway Credits: 3
Pathway Credits: 3
Total Credits: 17

Second Year Spring
PHY 207LR - General Physics III Credits: 4
PHY 257LAB - General Physics III Lab Credits: 1
Pathway Credits: 3
Pathway Credits: 3
Elective Credits: 3
Total Credits: 14

Third Year Fall
PHY 300/400 level Elective Credits: 3
LAI 350LEC - Introduction to Education Credits: 4
Communication Literacy 2 Credits: 3
Pathway Credits: 3
Total Credits: 13

Third Year Spring
PHY 307LAB - Modern Physics Lab Credits: 2
PHY 300/400 level Elective Credits: 3
CEP 400 Educational Psychology Credits: 3 ***OR***
ELP 405LEC - Sociology of Education Credits: 3
Pathway Credits: 3
Education Elective Credits: 3
UBC 399MNT UB Curriculum Capstone Credits: 1
Total Credits: 15

Fourth Year Fall
Education Elective Credits: 3
Education Elective Credits: 2
PHY 300/400 level Elective Credits: 3
Elective Credits: 4
Elective Credits: 3
Total Credits: 15

Fourth Year Spring
PHY 300/400 level Elective Credits: 3
Education Elective Credits: 3
Elective Credits: 3
Elective Credits: 3
Total Credits: 12

SUMMARY of Credit Hours

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

PHYSICS BA - 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
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)

CURRICULAR PLAN FOR TEACHING OF SCIENCE MAJORS

Provisional Certification in Physics and Chemistry

First Year Fall
UB Seminar Credits: 3
CHE 101LR - General Chemistry Credits: 4
CHE 113LAB - General Chemistry Credits: 1
MTH 141LR - College Calculus I Credits: 4
PHY 107LR - General Physics I Credits: 4 ***OR***
PHY 117LR - Honors Physics I Credits: 4
Total Credits: 16

First Year Spring
MTH 142LR - College Calculus 2 Credits: 4
PHY 108LR - General Physics II Credits: 4 ***OR***
PHY 118LR - Honors Physics II Credits: 4
PHY 158LAB - General Physics II Lab Credits: 1
CHE 102LR - General Chemistry Credits: 4
CHE 114LAB - General Chemistry Credits: 1
ENG 105LEC - Writing and Rhetoric Credits: 4
Total Credits: 18

Second Year Fall
MTH 241LR - College Calculus 3 Credits: 4
MTH 306LR - Introduction to Differential Equations Credits: 4
PHY 208LEC - General Physics IV Credits: 3
Pathway Credits: 3
Total Credits: 14

Second Year Spring
PHY 207LR - General Physics III Credits: 4
PHY 257LAB - General Physics III Lab Credits: 1
CHE 314LEC - Introduction to Analytical Chemistry Credits: 3
Pathway Credits: 3
Pathway Credits: 3
Total Credits: 14

Third Year Fall
CHE 203LEC - Organic Chemistry Credits: 3
CHE 205LBR -Organic Chemistry 1 LAB Credits: 2
LAI 350LEC - Introduction to Education Credits: 4
Communication Literacy 2 Credits: 3
Pathway Credits: 3
Total Credits: 15

Third Year Spring
PHY 307LAB - Modern Physics Lab Credits: 2
CHE 206LBR -Organic Chemistry 2 LAB Credits: 2
CHE 204LEC - Organic Chemistry Credits: 3
CEP 400 Educational Psychology Credits: 3 ***OR***
ELP 405LEC - Sociology of Education Credits: 3
Elective Credits: 3
Education Elective Credits: 3
Total Credits: 16

Fourth Year Fall
Education Elective Credits: 2
Education Elective Credits: 3
PHY 300/400 level Elective Credits: 3
Pathway Credits: 3
Pathway Credits: 3
UBC 399MNT UB Curriculum Capstone Credits: 1
Total Credits: 15

Fourth Year Spring
PHY 300/400 level Elective Credits: 3
Education Elective Credits: 3
Elective Credits: 3
Elective Credits: 3
Total Credits: 12

SUMMARY of Credit Hours

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

MATHEMATICAL PHYSICS – BS

Acceptance/Continuation Criteria: GPA of 2.5 in MTH 141–142, PHY 107–108/158. We are now requiring that our majors receive Cs or better in all these courses.

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
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)

CURRICULAR PLAN FOR BS IN MATHEMATICAL PHYSICS MAJORS

First Year Fall
UB Seminar Credits: 3
MTH 141LR - College Calculus I Credits: 4 ***OR***
MTH 153LR - Honors Calculus I Credits: 4
PHY 107LR - General Physics I Credits: 4 ***OR***
PHY 117LR - Honors Physics I Credits: 4
ENG 105LEC - Writing and Rhetoric Credits: 4
OR Pathway Credits: 3
Total Credits: 14 or 15

First Year Spring
MTH 142LR - College Calculus 2 Credits: 4 ***OR***
MTH 154LR - Honors Calculus 2 Credits: 4
PHY 108LR - General Physics II Credits: 4 ***OR***
PHY 118LR - Honors Physics II Credits: 4
PHY 158LAB - General Physics II Lab Credits: 1
ENG 105LEC - Writing and Rhetoric Credits: 4
OR Pathway Credits: 3
Pathway Credits: 3
Total Credits: 15 or 1

Second Year Fall
MTH 241LR - College Calculus 3 Credits: 4 ***OR***
MTH 251LR - Honors Calculus 3 Credits: 4
MTH 306LR - Introduction to Differential Equations Credits: 4 ***OR***
MTH 326LR - Honors Diff Equations Credits: 4
PHY 208LEC - General Physics IV Credits: 3
Pathway Credits: 3
Elective Credits: 1
Total Credits: 15

Second Year Spring
PHY 207LR - General Physics III Credits: 4
MTH 309LR - Introductory Linear Algebra Credits: 4 ***OR***
MTH 323LR - Honors Linear Algebra Credits: 4
PHY 257LAB - General Physics III Lab Credits: 1
Pathway Credits: 3
Pathway Credits: 3
Total Credits: 15

Third Year Fall
MTH 417LR - Survy of Multivari Calcs Credits: 4
PHY 301LEC - Intermediate Mechanics I Credits: 3
PHY 401LEC - Quntum Mchnics I Credits: 3
Communication Literacy 2 Credits: 3
Pathway Credits: 3
UBC 399MNT -UB Capstone Credits: 1
Total Credits: 17

Third Year Spring
MTH 418LR - Survey of Partial Differential Equations Credits: 4
PHY 307LAB - Modern Physics Lab Credits: 2
PHY Elective Credits: 3
Elective Credits: 3
Elective Credits: 3
Total Credits: 15

Fourth Year Fall
MTH 311LR - Introduction to Higher Mathematics Credits: 4
PHY 405LEC - Thermal and Statistical Physics I Credits: 3
PHY 431LEC - Mathematical Physics I Credits: 3
Elective Credits: 2
PHY 403LEC - Electricity and Magnetism I Credits: 3
Total Credits: 15

Fourth Year Spring
MTH 425LR - Introduction to Complex Variables I Credits: 4 ***OR***
MTH 424LEC - Survey of Fourier Series Methods Credits: 3
MTH 419LR - Introduction to Abstract Algebra Credits: 4 ***OR***
MTH 420LR - Abstract Linear Algebra Credits: 4
PHY 408LAB - Advanced Laboratory Credits: 3
OR
PHY 407LAB - Advanced Laboratory Credits: 3 (Fall)
Elective Credits: 3
Total Credits: 13 or 14

SUMMARY of Credit Hours

Total required credit hours in mathematics and physics	78
UB Curriculum courses and electives	42
Total required credit hours	120

COMPUTATIONAL PHYSICS—BS

Acceptance/Continuation Criteria: GPA of 2.5 in CSE 115–116, MTH 141–142, PHY 107–108/158. We are now requiring that our majors receive Cs or better in all these courses.

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
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)

CURRICULAR PLAN FOR BS IN COMPUTATIONAL PHYSICS MAJORS

First Year Fall
UB Seminar Credits: 3
CSE 115LLR - Introduction to Computer Science I Credits: 4
MTH 141LR - College Calculus I Credits: 4
Physics Sequence 1 Credits: 4
Total Credits: 15

First Year Spring
CSE 116LLB - Introduction to Computer Science II Credits: 4
MTH 142LR - College Calculus 2 Credits: 4
Physics Sequence 1 Credits: 4
PHY 158LAB - General Physics II Lab Credits: 1
ENG 105LEC - Writing and Rhetoric Credits: 4
Total Credits: 17

Second Year Fall
CSE 191LR - Intro to Discrete Structures Credits: 4
MTH 241LR - College Calculus 3 Credits: 4
MTH 306LR - Introduction to Differential Equations Credits: 4
PHY 208LEC - General Physics IV Credits: 3
Pathway Credits: 3
Total Credits: 18

Second Year Spring
CSE 250LR - Data Structures Credits: 4
PHY 207LR - General Physics III Credits: 4
PHY 257LAB - General Physics III Lab Credits: 1
Pathway Credits: 3
Pathway Credits: 3
Pathway Credits: 3
Total Credits: 18

Third Year Fall
CSE 442LR - Software Engineering Credits: 4
PHY 301LEC - Intermediate Mechanics I Credits: 3
PHY 401LEC - Quantum Mechanics I - Fundamentals Credits: 3
Communication Literacy 2 Credits: 3
Total Credits: 13

Third Year Spring
MTH 309LR - Introductory Linear Algebra Credits: 4
PHY 307LAB - Modern Physics Lab Credits: 2
CSE 305LR - Introduction to Programming Languages Credits: 4
Pathway Credits: 3
Total Credits: 13

Fourth Year Fall
PHY 403LEC - Electricity and Magnetism I Credits: 3
PHY 410 Computational Physics I Credits: 3 ***OR***
MTH 437LR - Introduction to Numerical Analysis I Credits: 4
PHY 405LEC-Thermal and Statistical Physics I Credits: 3
Pathway Credits: 3
UBC 399MNT UB Curriculum Capstone Credits: 1
Total Credits: 13

Fourth Year Spring
PHY 411 Computational Physics II Credits: 3 ***OR***
MTH 438LR - Introduction to Numerical Analysis II Credits: 4
PHY 408LAB - Advanced Laboratory Credits: 3
EAS 305LR - Applied Probability and Statistics Credits: 4 ***OR***
MTH 411LR - Probability Theory Credits: 4
Elective Credits: 3
Total Credits: 13

SUMMARY of Credit Hours

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

5 YEAR BS IN COMPUTATIONAL PHYSICS/MS IN PHYSICS

Acceptance/Continuation 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
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)

CURRICULAR PLAN FOR BS IN COMPUTATIONAL PHYSICS/MS IN PHYSICS MAJORS

First Year Fall
UB Seminar Credits: 3
CSE 115LLR - Introduction to Computer Science I Credits: 4
MTH 141LR - College Calculus I Credits: 4
PHY 107LR - General Physics I Credits: 4 ***OR***
PHY 117LR - Honors Physics I Credits: 4
Pathway Credits: 3
Total Credits: 18

First Year Spring
CSE 116LLB - Introduction to Computer Science II Credits: 4
MTH 142LR - College Calculus 2 Credits: 4
PHY 108LR - General Physics II Credits: 4 ***OR***
PHY 118LR - Honors Physics II Credits: 4
PHY 158LAB - General Physics II Lab Credits: 1
ENG 105LEC - Writing and Rhetoric Credits: 4
Total Credits: 17

Second Year Fall
CSE 191LR - Introduction to Discrete Structures Credits: 4 ***OR***
MTH 241LR - College Calculus 3 Credits: 4
MTH 306LR - Intro to Diffntial Eqations Credits: 4
PHY 208LEC - General Physics IV Credits: 3
Pathway Credits: 3
Total Credits: 18

Second Year Spring
CSE 250LR - Data Structures Credits: 4
PHY 207LR - General Physics III Credits: 4
PHY 257LAB - General Physics III Lab Credits: 1
Pathway Credits: 3
Pathway Credits: 3
Total Credits: 15

Third Year Fall
CSE 442LR - Software Engineering Credits: 4
PHY 301LEC - Intermediate Mechanics I Credits: 3
PHY 401LEC - Quantum Mechanics I - Fundamentals Credits: 3
Communication Literacy 2 Credits: 3
Pathway Credits: 3
Total Credits: 16

Third Year Spring
MTH 309LR - Introductory Linear Algebra Credits: 4
PHY 307LAB - Modern Physics Lab Credits: 2
CSE 305LR - Introduction to Programming Languages Credits: 4
Pathway Credits: 3
UBC 399MNT UB Curriculum Capstone Credits: 1
Total Credits: 14

Fourth Year Fall
PHY 403LEC - Electric and Magnetism I Credits: 3
PHY 405LEC - Thermal and Stats Phys I Credits: 3
Calc-Based Probability/Stats Elective Credits: 4
PHY 505LEC - Computational Physics 1 Credits: 3
Total Credits: 13

Fourth Year Spring
PHY 506LEC - Computational Physics 2 Credits: 3
PHY 552 Credits: 3 ***OR*** PHY 551 Credits: 3 (fall)
PHY 500-level elect. (and MS Thesis) Credits: 3
Total Credits: 9

Fifth Year Fall
PHY 515LEC - High Perform Computing 1 Credits: 3
PHY 500-level elect. (and MS Thesis) Credits: 3
PHY 500-level elect. (and MS Thesis) Credits: 3
Total Credits: 9

Fifth Year Spring
PHY 516LEC - High Perform Computing 2 Credits: 3
PHY 500-level elect. (and MS Thesis) Credits: 3
PHY 500-level elect. (and MS Thesis) Credits: 3
Total Credits: 9

SUMMARY of Credit Hours

Total required Undergraduate credit hours in computer science, mathematics, and physics	78
UB Curriculum courses and electives	32
Graduate credit hours	30
Total required credit hours	140

Physics BA - Teaching of Science Physics Concentration/Physics Adolescent Education EdM

Undergraduate Course Requirements

PHY 107LR - General Physics I Credits: 4
PHY 108LR - General Physics II Credits: 4
PHY 158LAB - General Physics II Lab Credits: 1
PHY 207LR - General Physics III Credits: 4
PHY 208LEC - General Physics IV Credits: 3
PHY 257LAB - General Physics III Lab Credits: 1
PHY 307LAB - Modern Physics Lab Credits: 2
PHY 401LEC - Quantum Mechanics I - Fundamentals Credits: 3
One PHY Elective Credits: 3
One PHY 300/400 level Elective Credits: 3 (excluding PHY, 497, 498, and 499)
CHE 101LR - General Chemistry Credits: 4
CHE 102LR - General Chemistry Credits: 4
CHE 113LAB - General Chemistry Credits: 1
CHE 114LAB - General Chemistry Credits: 1
MTH 141LR - College Calculus I Credits: 4
MTH 142LR - College Calculus 2 Credits: 4
MTH 241LR - College Calculus 3 Credits: 4
MTH 306LR - Introduction to Differential Equations Credits: 4
CEP 400LEC - Educational Psychology Credits: 3 *
ELP 405LEC - Sociology of Education Credits: 3 *
LAI 350LEC - Introduction to Education Credits: 4
LAI 474SEM - Teaching the Exceptional Learner in the Regular Education Classroom Credits: 3 *
LAI 414LEC - Adolescent Writing Across the Curriculum Credits: 3 *

Graduate Course Requirements

LAI 533 Science Instruction Topics
LAI 534 Measurement and Evaluation in Science Instruction ***OR*** LAI 515 Action Research to Improve Teaching and Learning
LAI 552 Middle Childhood/Adolescent Literacy Methods
LAI 595 Supervised Teaching II
LAI 619 Methods for Teaching Science (Grades 5-12)
LAI 667 Field Experience
LAI 668 Supervised Teaching I
LAI 674 Seminar in Teaching
LAI 698 Instructional Strategies in Inclusive Classrooms
Four Physics Electives (12 credits)
Advisor approved 500 level science and/or science education electives offered through the College of Arts and Sciences or the Graduate School of Education and/or: LAI 531, LAI 532, LAI 535, LAI 637, LAI 639.

LAI 700TUT - Capstone

Additional Degree Requirements Include:

Additional coursework to fulfill UB Curriculum requirements.
16 credits of Education Core*

Curricular Plan

A Curricular Plan provides a roadmap for completing this academic program and the UB Curriculum on time. Your actual plan may vary depending on point of entry to the university, course placement and/or waivers based on standardized test scores, earned alternative credit and/or college transfer credit.

First Year Fall
UB Seminar Credits: 3
CHE 101LR - General Chemistry Credits: 4
CHE 113LAB - General Chemistry Credits: 1
MTH 141LR - College Calculus I Credits: 4
PHY 107LR - General Physics I Credits: 4
Total Credits: 16

First Year Spring
MTH 142LR - College Calculus 2 Credits: 4
PHY 108LR - General Physics II Credits: 4
PHY 158LAB - General Physics II Lab Credits: 1
CHE 102LR - General Chemistry Credits: 4
CHE 114LAB - General Chemistry Credits: 1
ENG 105LEC - Writing and Rhetoric Credits: 4
Total Credits: 18

Second Year Fall
MTH 241LR - College Calculus 3 Credits: 4
MTH 306LR - Intro to Diffntial Eqtions Credits: 4
PHY 208LEC - General Physics IV Credits: 3
Pathway Credits: 3
Pathway Credits: 3
Total Credits: 17

Second Year Spring
PHY 207LR - General Physics III Credits: 4
PHY 257LAB - General Physics III Lab Credits: 1
Pathway Credits: 3
Pathway Credits: 3
Total Credits: 11

Third Year Fall	Third Year Spring
PHY 401LEC - Quantum Mechanics I - Fundamentals Credits: 3 LAI 350LEC - Introduction to Education Credits: 4 Communication and Literacy 2 (LAI 301 recommended) Credits: 3 Pathway Credits: 3 Pathway Credits: 3 **Total Credits: 16**	PHY Elective Credits: 3 PHY 300/400 level Elective Credits: 3 PHY 307LAB - Modern Physics Lab Credits: 2 CEP 400LEC - Educational Psychology Credits: 3 UBC 399MNT UB Curriculum Capstone Credits: 1 LAI 474SEM - Teaching the Exceptional Learner in the Regular Education Classroom Credits: 3 **Total Credits: 15**
Fourth Year Fall	**Fourth Year Spring**
PHY 500 level Elective Credits: 3 PHY 500 level Elective Credits: 3 LAI 619LEC - Methods for Teaching Sciences (Grades 5-12) Credits: 3 LAI 698LEC - Instructional Strategies in Inclusive Classrooms Credits: 3 ELP 405LEC - Sociology of Education Credits: 3 **Total Credits: 15**	LAI 414LEC - Adolescent Writing Across the Curriculum Credits: 3 LAI 552LEC - Mid Chld/Adoles Ltrcy Mtd Credits: 3 PHY 500 level Elective Credits: 3 PHY 500 level Elective Credits: 3 **Total Credits: 12**
Fifth Year Fall	**Fifth Year Spring**
LAI 667TUT - Field Experience Credits: 3 LAI 668TUT - Supervised Teaching I Credits: 3 LAI 534LEC - Meas & Eval of STEM ***OR*** LAI 515LEC - Action Research to Improve Teaching and Learning Credits: 3 **Total Credits: 9**	LAI 674TUT - Seminar in Teaching Credits: 3 LAI 595TUT - Supervised Teaching II Credits: 3 LAI 533SEM - Science Instruction Topic Credits: 3 LAI 700TUT - Indiv Guidnc Capstn Event Credits: 1 **Total Credits: 10**

SUMMARY of Credit Hours

Total Credits Required for Undergraduate Major:	54
Total Credits Required for Major:	99
Total Graduate Credits Required for Degree:	40
Total Credits Required for Graduation:	139

Physics BA -Teaching of Science Physics and Chemistry/Physics Adolescent Education EdM

Undergraduate Course Requirements

PHY 107LR - General Physics I Credits: 4 ***OR***
PHY 117LR - Honors Physics I Credits: 4
PHY 108LR - General Physics II Credits: 4 ***OR***
PHY 118LR - Honors Physics II Credits: 4

PHY 158LAB - General Physics II Lab Credits: 1
PHY 207LR - General Physics III Credits: 4
PHY 208LEC - General Physics IV Credits: 3
PHY 257LAB - General Physics III Lab Credits: 1
PHY 307LAB - Modern Physics Lab Credits: 2
PHY 401LEC - Quantum Mechanics I - Fundamentals Credits: 3
CHE 101LR - General Chemistry Credits: 4
CHE 102LR - General Chemistry Credits: 4
CHE 113LAB - General Chemistry Credits: 1
CHE 114LAB - General Chemistry Credits: 1
CHE 203LEC - Organic Chemistry Credits: 3
CHE 204LEC - Organic Chemistry Credits: 3
CHE 205LBR - Organic Chemistry 1 LAB Credits: 2
CHE 206LBR - Organic Chemistry 2 LAB Credits: 2
CHE 314LEC - Introduction to Analytical Chemistry Credits: 3
CHE 300/400 level Elective Credits: 3
MTH 141LR - College Calculus I Credits: 4
MTH 142LR - College Calculus 2 Credits: 4
MTH 241LR - College Calculus 3 Credits: 4
MTH 306LR - Introduction to Differential Equations Credits: 4
CEP 400LEC - Educational Psychology Credits: 3 *
ELP 405LEC - Sociology of Education Credits: 3 *
LAI 350LEC - Introduction to Education Credits: 4
LAI 414LEC - Adolescent Writing Across the Curriculum Credits: 3 *
LAI 474SEM - Teaching the Exceptional Learner in the Regular Education Classroom Credits: 3 *

Graduate Course Requirements

LAI 533 Science Instruction Topics
LAI 534 Measurement and Evaluation in Science Instruction ***OR*** LAI 515 Action Research to Improve Teaching and Learning
LAI 552 Middle Childhood/Adolescent Literacy Methods
LAI 595 Supervised Teaching II
LAI 619 Methods for Teaching Science (Grades 5-12)
LAI 667 Field Experience
LAI 668 Supervised Teaching I
LAI 674 Seminar in Teaching
LAI 698 Instructional Strategies in Inclusive Classrooms
Four Physics Electives (12 credits)
Advisor approved 500 level science and/or science education electives offered through the College of Arts and Sciences or the Graduate School of Education and/or: LAI 531, LAI 532, LAI 535, LAI 637, LAI 639.
LAI 700TUT - Capstone

Additional Degree Requirements Include:

Additional coursework to fulfill UB Curriculum requirements
16 credits of Education Core*

Academic Requirements

To progress to the graduate portion of the program, students must maintain a 3.000 GPA, earn a "C" grade or higher in content courses (courses in the undergraduate major); earn a "B-" or better in all education coursework (courses that begin with CEP, ELP, and LAI), and complete an interview in the Office of Educator Preparation. Students must complete these progression points by March of year three of the bachelor's program to be eligible to register for graduate level coursework. No formal application is required for graduate school.

Curricular Plan

A Curricular Plan provides a roadmap for completing this academic program and the UB Curriculum on time. Your actual plan may vary depending on point of entry to the university, course placement and/or waivers based on standardized test scores, earned alternative credit and/or college transfer credit.

First Year Fall	**First Year Spring**
UB Seminar Credits: 3	MTH 142LR - College Calculus 2 Credits: 4
CHE 101LR - General Chemistry Credits: 4	PHY 108LR - General Physics II Credits: 4
CHE 113LAB - General Chemistry Credits: 1	PHY 158LAB - General Physics II Lab Credits: 1
MTH 141LR - College Calculus I Credits: 4	CHE 102LR - General Chemistry Credits: 4
PHY 107LR - General Physics I Credits: 4	CHE 114LAB - General Chemistry Credits: 1
Total Credits: 16	ENG 105LEC - Writing and Rhetoric Credits: 4
	Total Credits: 18
Second Year Fall	**Second Year Spring**
MTH 241LR - College Calculus 3 Credits: 4	PHY 207LR - General Physics III Credits: 4
MTH 306LR - Intro to Differential Equations Credits: 4	PHY 257LAB - General Physics III Lab Credits: 1
PHY 208LEC - General Physics IV Credits: 3	Pathway Credits: 3
Pathway Credits: 3	Pathway Credits: 3
Pathway Credits: 3	CHE 314LEC - Intro to Analytical Chem Credits: 3
Total Credits: 17	**Total Credits: 14**
Third Year Fall	**Third Year Spring**
Communication and Literacy 2 (LAI 350 recommended) Credits: 3	Pathway Credits: 3
Pathway Credits: 3	PHY 307LAB - Modern Physics Lab Credits: 2
CHE 203LR - Organic Chemistry Credits: 4	CHE 204LR - Organic Chemistry Credits: 4
CHE 205LAB - Organic Chemistry 1 LAB Credits: 1	CHE 206LAB - Organic Chemistry 2 LAB Credits: 1
LAI 350LEC - Introduction to Education Credits: 4	CEP 400LEC - Educational Psychology Credits: 3
PHY 401LEC - Quantum Mechanics I - Fundamentals Credits: 3	LAI 474SEM - Teaching the Exceptional Learner in the Regular Education Classroom Credits: 3
Total Credits: 18	**Total Credits: 16**

Fourth Year Fall	Fourth Year Spring
LAI 619LEC - Teaching Science Grades 5-12 Credits: 3 PHY 500 level Elective Credits: 3 LAI 698LEC - Instructional Strategies in Inclusive Classrooms Credits: 3 CHE 300/400 Elective level Credits: 3 ELP 405LEC - Sociology of Education Credits: 3 UBC 399MNT - UB Curriculum Capstone Credits: 1 **Total Credits: 16**	PHY 500 level Elective Credits: 3 PHY 500 level Elective Credits: 3 LAI 552LEC - Mid Chld/Adoles Ltrcy Mtd Credits: 3 LAI 414LEC - Adolescent Writing Across the Curriculum Credits: 3 **Total Credits: 12**
Fifth Year Fall	**Fifth Year Spring**
PHY 500 level Elective Credits: 3 LAI 668TUT - Supervised Teaching I Credits: 3 LAI 667TUT - Field Experience Credits: 3 LAI 534LEC - Meas & Eval of STEM OR LAI 515LEC - Action Research to Improve Teaching and Learning Credits: 3 **Total Credits: 12**	LAI 674TUT - Seminar in Teaching Credits: 3 LAI 595TUT - Supervised Teaching II Credits: 3 LAI 533SEM - Science Instruction Topic Credits: 3 LAI 700TUT - Indiv Guidnc Capstn Event Credits: 1 **Total Credits: 10**

SUMMARY of Credit Hours

Total Credits Required for Undergraduate Major:	64
Total Credits Required for Major:	109
Total Graduate Credits Required for Degree:	40
Total Credits Required for Graduation:	149

PHYSICS BS / MATERIALS DESIGN AND INNOVATION MS

Admission Criteria: Current UB students seeking admission to the Physics BS may request admission by completing the Undergraduate Major/Minor Change Request Form.

Acceptance/Continuation Criteria: Grades of C or better in PHY 107 or PHY 117, PHY 108 or PHY 118, PHY 158, MTH 141, and MTH 142.

REQUIRED COURSES

Physics Core (74 credits)
CHE 101LR - General Chemistry
CHE 113LAB - General Chemistry
CHE 102LR - General Chemistry
CHE 114LAB - General Chemistry
MTH 141LR - College Calculus I
MTH 142LR - College Calculus II
MTH 241LR - College Calculus III
MTH 306LR - Introduction to Differential Equations
MTH 417LR - Survey of Multivariable Calculus
MTH 418LR - Survey of Partial Differential Equations
PHY 107LR - General Physics I OR
PHY 117LR - Honors Physics I
PHY 108LR - General Physics II OR
PHY 118LR - Honors Physics II
PHY 158LAB - General Physics II Lab
PHY 207LR - General Physics III
PHY 208LEC - General Physics IV
PHY 257LAB - General Physics III Lab
PHY 301LEC - Intermediate Mechanics I
PHY 302LEC - Intermediate Mechanics II
PHY 307LAB - Modern Physics Lab
PHY 401LEC - Quantum Mechanics I - Fundamentals
PHY 402LEC - Quantum Mechanics II - Applications
PHY 403LEC - Electricity and Magnetism I
PHY 404LEC - Electricity and Magnetism II
PHY 405LEC - Thermal and Statistical Physics I (replaced by MDI 504 in the joint program)
PHY 407LAB - Advanced Laboratory OR
PHY 408LAB - Advanced Laboratory

Joint Program Substitutions: PHY 405 is not required for students in the combined BS/MS program and is replaced by MDI 504 - Multivariate Statistics and Materials Informatics. Three Materials Design and Informatics graduate courses also replace the Physics BS PHY and technical electives.

*The catalog describes substitutions of graduate coursework for PHY 405 and for PHY/technical electives. The 74-credit Physics Core figure is reproduced from the catalog. Graduate course distribution should be checked against the Graduate Catalog and an individual advisement report.

Note: Some classes may fulfill both major and UB Curriculum requirements. Actual course sequencing may vary based on placement, transfer credit, waivers, and individual academic plans.

CURRICULAR PLAN FOR BS IN PHYSICS / MS IN MATERIALS DESIGN AND INNOVATION MAJORS

A Curricular Plan provides a roadmap for completing this academic program and the UB Curriculum on time. Your actual plan may vary depending on point of entry to the university, course placement and/or waivers based on standardized test scores, earned alternative credit and/or college transfer credit.

First Year Fall	First Year Spring
UB Seminar Credits: 3 CHE 101LR - General Chemistry Credits: 4 CHE 113LAB - General Chemistry Credits: 1 MTH 141LR - College Calculus I Credits: 4 PHY 107LR - General Physics I Credits: 4 OR PHY 117LR - Honors Physics I Credits: 4 **Total Credits: 16**	MTH 142LR - College Calculus II Credits: 4 PHY 108LR - General Physics II Credits: 4 OR PHY 118LR - Honors Physics II Credits: 4 PHY 158LAB - General Physics II Lab Credits: 1 CHE 102LR - General Chemistry Credits: 4 CHE 114LAB - General Chemistry Credits: 1 ENG 105LEC - Writing and Rhetoric Credits: 4 **Total Credits: 18**
Second Year Fall	**Second Year Spring**
MTH 241LR - College Calculus III Credits: 4 MTH 306LR - Introduction to Differential Equations Credits: 4 PHY 208LEC - General Physics IV Credits: 3 Pathway Credits: 3 Pathway Credits: 3 **Total Credits: 17**	MTH 418LR - Survey of Partial Differential Equations Credits: 4 PHY 207LR - General Physics III Credits: 4 PHY 257LAB - General Physics III Lab Credits: 1 Pathway Credits: 3 Pathway Credits: 3 **Total Credits: 15**
Third Year Fall	**Third Year Spring**
MTH 417LR - Survey of Multivariable Calculus Credits: 4 PHY 301LEC - Intermediate Mechanics I Credits: 3 PHY 401LEC - Quantum Mechanics I - Fundamentals Credits: 3 Communication Literacy 2 Credits: 3 **Total Credits: 13**	PHY 302LEC - Intermediate Mechanics II Credits: 3 PHY 307LAB - Modern Physics Lab Credits: 2 PHY 402LEC - Quantum Mechanics II - Applications Credits: 3 Pathway Credits: 3 Pathway Credits: 3 **Total Credits: 14**

Fourth Year Fall	Fourth Year Spring
PHY 403LEC - Electricity and Magnetism I Credits: 3 PHY 407LAB - Advanced Laboratory Credits: 3 OR PHY 408LAB - Advanced Laboratory Credits: 3 UBC 399MNT - UB Curriculum Capstone Credits: 1 Graduate credits as appropriate **Total Credits: 7+**	PHY 404LEC - Electricity and Magnetism II Credits: 3 Graduate credits as appropriate **Total Credits: 3+**

Graduate Coursework: The graduate portion of the program follows the Materials Design and Innovation MS curriculum listed in the Graduate Catalog. The undergraduate plan does not specify all graduate courses by semester.

SUMMARY of Credit Hours	
Total Credits Required for Undergraduate Major:	74
Total undergraduate credits required:	103
Total Graduate Credits Required for Degree:	30
Total Credits Required for Graduation:	133

IV. UB CURRICULUM REQUIREMENTS

The UB Curriculum makes general education a purposeful program with a beginning and an end, where every step of the journey builds on the last, readying graduates for everything to come. Instead of requiring a fixed regimen of large general education classes, the UB curriculum allows students to tailor their general education based on their interests.

The UB Curriculum is divided into four general areas:

1. **UB Seminar: The entryway to your UB education. A discussion-based seminar built around grand challenges and big ideas.**

UB Seminar Transfer students entering UB will enroll in the one-credit UB Seminar. All first year students will take the three-credit UB Seminar.	3 or 1 credits

2. **Foundations: Courses in diversity, writing, math and natural sciences that promote critical thinking, creative problem-solving, enhanced communication skills, cultural competencies, and ethical and analytical reasoning.**

Communication Literacy 1	4 credits
Communication Literacy 2	3 credits
Math and Quantitative Reasoning	4 credits
Scientific Literacy and Inquiry Sequence	7 credits
Diversity in the United Stated Requirement	Satisfied within the Pathways

3. **Pathways: A series of courses interconnected by theme or concept across a wide range of disciplines. Pathways can be customized to complement pre-existing interests or to expand horizons and engage curiosity.**

Thematic Pathway	9 credits
Global Pathway	9 credits

4. **Capstone: A final project that integrates the whole in anticipation of next steps in life and learning.**

Capstone	1 credit

Please see https://www.buffalo.edu/ubcurriculum.html **for more information.**

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 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 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. For problems arising in connection with UB Curriculum Requirements, it is best to consult with Ms. Elizabeth Kerr, Assistant Director of Academic Advisement in the CAS Student Advisement and Services (eakerr@buffalo.edu, 645–6883, 275 Park Hall).
(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.

Force Registration

Students can submit force registration requests for the following reasons:

1. Prerequisite or Corequisite Missing. This is only accepted if the following conditions apply:

Transfer work is in progress or has not been received by UB. Students must supply proof of enrollment and completion of the prerequisite or corequisite courses.
Student received an exception to use a specific course in lieu of a prerequisite or corequisite, or needs to request permission from the course instructor to waive a prerequisite or corequisite.
2. Course is Closed. Be sure to add a different open section, or enroll to the waitlist, if available.

3. Repeat. Students are permitted to self-enroll in a class twice. Any attempts to register for the class beyond the two permitted must be approved by the department. Policies can be viewed here: repeat policy

4. Permission Required. This pertains to classes that require specific permissions, i.e. internships, undergraduate research, etc.

NOTE: We do not Force Register into labs. There are NO EXCEPTIONS.

You may not request Force Registration if you are not in the reserve group.

VI. PROCEDURES FOR APPLYING TO DEGREE PROGRAMS

If you are not already directly admitted into one of our degree programs, please contact Professor Cerne about being admitted into a physics major. 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 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. Students who are directly admitted into a physics major will still need to meet the pre-requisite course GPA requirements to continue in that major after they complete the perquisite courses.

VII. DEPARTMENT HONORS (SENIOR THESIS) AND GRADUATING WITH DISTINCTION

Program Honors: Physics majors who meet the following criteria may be awarded Program Honors for the Major:

1. The student has completed at least 50% of the major credit hours at UB and these are graded credits, i.e., not "satisfactory-unsatisfactory [grades of 'S' or 'U']".

2. The student has completed an honors thesis, project, or Honors program seminar as an additional component of the major.

3. The student's UB grade point average for the major (not overall GPA) is:
   a) at least 3.20 but less than 3.50: Program Honors are "With Honors and Distinction"
   b) at least 3.50 but less than 3.75: Program Honors are "With High Honors and Distinction"
   c) 3.75 or more: Program Honors are "With Highest Honors and Distinction"

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 Physics Honors Thesis 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.

Program Distinction: Physics majors and minors are to be also eligible to graduate with program distinction if they meet the following criteria:

1. The student has completed at least 50% of the major or minor credit hours at UB and these are graded credits, i.e., not "satisfactory-unsatisfactory [grades of 'S' or 'U']".

2. The student's UB grade point average for the major or minor (not overall GPA) is:
   a) at least 3.20 but less than 3.50: Program Distinction is "With Distinction,"
   b) at least 3.50 but less than 3.75: Program Distinction is "With High Distinction"
   c) 3.75 or more: Program Distinction is "With Highest Distinction."

The Department of Physics is not authorized to bestow honors/distinction upon Engineering Physics students. This is handled by the Department of Electrical Engineering.

VIII. DEPARTMENTAL AWARDS

The Department of Physics selects our top students for two scholarships: 1) Dr. Stanley T. Sekula Memorial Scholarship and 2) Om and Saraswati Bahethi Foundation Fellowship Fund. This involves a monetary award. We also induct our top majors into the ΣΠΣ Honor Society. Since engineering physics students are under the Department of Electrical Engineering, they are not eligible for these scholarships/awards.

IX. 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 UB's Experiential Learning Network at https://www.buffalo.edu/eln.html. This web page describes the undergraduate research opportunities at UB. You can also directly contact physics faculty to find out if they have any research projects available for undergraduate students. Please contact them well before the semester begins. Coming up with and supervising an undergraduate research project can put a significant extra burden on the faculty, so do not assume that you will automatically get to do research with whomever and whenever you choose. With the instructor's permission, you will be force-registered into PHY 499-TUT (Undergraduate Independent Study) or PHY 498 (Undergraduate Research). We recommend that you register for PHY 498 since it focuses on research experience. You will need to choose for how many credits (1-3) you wish to take PHY 498 and 499. Please discuss this with the instructor and be prepared to spend as much, if not more, time on these courses. Do not take these courses is you already have a full course load! Although the credits will apply towards your total number of credits, these are not degree applicable credits(do not satisfy TAP requirements) and will not replace the required courses.

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. If you do research at UB or elsewhere during the summer, you should expect to get paid (unlike PHY 49x).

X. 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, 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
For more information and resources on physics careers, please visit:

https://www.aps.org/careers/index.cfm and https://www.aip.org/career-resources

We also recommend that you talk with our Director of Graduate Studies for advice on physics graduate schools and applying to them.

APPENDIX A.

ACCEPTANCE CRITERIA FOR TRANSFER AND MAJOR-SWITCHING 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 for Physics BA and BS degrees, and a GPA of 2.5 or better for the Mathematical Physics and Computational Physics BS degrees:

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.

We are now requiring that our majors receive Cs or better in all these courses.

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.

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.

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 UB Curriculum 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 UB Curriculum 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 UB Curriculum 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 141, 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 UB Curriculum requirement sequence.

PHY 115 Relativity Seminar for Non specialists
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 UB Curriculum 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 UB Curriculum 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 121is 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 UB Curriculum 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 UB Curriculum 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 UB Curriculum 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 UB Curriculum 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 UB Curriculum 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 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; 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; 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 ; 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; 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; CSE 115
Corequisites: PHY 401
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
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 binging, 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.