Physics, BS

Physics is the study of matter and energy and their interactions in nature and under man-made conditions. Everything is comprised of matter and energy so the principles of physics touch everything in the world around us and beyond the bounds of Earth into the Universe.

UWM students can shape their Physics major in one of two directions. The standard major provides a broad overview of all aspects of physics: mechanics, optics and lasers, thermodynamics, quantum physics, magnetism, electricity, and the math principles that underlie everything in physics. In the astronomy focused version of the major, students still master these basics plus they add in additional coursework in astrophysics and gravitation.

UWM’s program provides excellent preparation for graduate programs in physics, engineering, and math or can serve as a springboard to careers in areas of electronics and computers; space travel and space exploration; satellite technology; medical imaging and treatment; telecommunications; nuclear power; semi- and super-conductors; environmental consulting; climatology; green energy; and more.

The opportunity to participate in research as an undergraduate is a distinct advantage to being a Physics student at UWM. At most large, research universities, research opportunities for undergraduates are limited; there are fewer of them and they are often reserved for juniors or seniors. At UWM, you can get involved as early as freshman year. Students work directly with faculty and graduate students on their current research projects, and sometimes find themselves published in a peer-reviewed journal right alongside the faculty member. Participating in undergraduate research is an excellent way to enhance your resume for graduate school or employment.

Requirements

Course of Study – Bachelor of Science Degree

Complete 120 credits including 90 credits in the College of Letters & Science and with 36 of the 90 credits in L&S upper-level (numbered above 300) courses and 30 of those 36 credits in designated upper-level Natural Science. The College requires that students must complete in residence at UWM at least 15 credits in upper-division (numbered 300 or above) courses in their major. Students are also required to complete University-wide General Education Requirements and the specific L&S requirements listed below.

To complete a major, students must satisfy all the requirements of the major as stated in this catalog. Students who declare their majors within five years of entering the UW System as a degree candidate may satisfy the requirements outlined in any catalog issued since the time they entered. Credits used to satisfy the major also may be used to satisfy other degree requirements.

University General Education Requirements (GER)

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Oral and Written Communication</td>
<td></td>
</tr>
<tr>
<td>Part A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ENGLISH 102</td>
<td>College Writing and Research (or equivalent)</td>
<td></td>
</tr>
<tr>
<td>Part B</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Quantitative Literacy

Part A

Select one of the following:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 103</td>
<td>Contemporary Applications of Mathematics</td>
</tr>
<tr>
<td>MATH 105</td>
<td>Introduction to College Algebra</td>
</tr>
<tr>
<td>MATH 108</td>
<td>Algebraic Literacy II</td>
</tr>
<tr>
<td>MATH 111</td>
<td>Introduction to Logic - Critical Reasoning 1</td>
</tr>
<tr>
<td>or PHILOS 111</td>
<td>Introduction to Logic - Critical Reasoning</td>
</tr>
</tbody>
</table>

Or equivalent course

Part B

Course designated as OWC-B; may be completed through a major-specific course requirement

Arts

Select 3 credits

Humanities

Select 6 credits

Social Sciences

Select 6 credits

Natural Sciences

Select 6 credits (At least two courses including one lab)

UWM Foreign Language Requirement

Complete Foreign Language Requirement through:

- Two years (high school) of a single foreign language
- Two semesters (college) of a single foreign language

Or equivalent

UWM Cultural Diversity Requirement

One course from the Arts, Humanities, or Social Sciences must also satisfy UWM’s Cultural Diversity requirement

1 Math 111 and Philosophy 111 are jointly offered and count as repeats of one another. Students cannot receive credit for both courses.

College of Letters & Science Requirements

I. English Writing Requirement

Students must satisfy the English Writing Requirement by completing ENGLISH 102 with a grade of C or higher or by placing beyond English 102 on the English Placement Test (EPT).

Note: This requirement is the same as the University General Education Requirement for Oral and Written Communication Part A. The College of Letters & Science does not have a specific requirement for a writing course beyond English 102, but students must complete the university-wide requirement for Oral and Written Communication Part B listed above.

II. Mathematics and Formal Reasoning

To satisfy the Mathematics and Formal Reasoning Requirement, Bachelors of Sciences degree students must satisfy the following two requirements:

1. Complete one of the following courses or an equivalent course:
See Approved Courses for the L&S International Requirement (http://catalog.uwm.edu/letters-science/approved-courses-international-requirement) for course options.
requirement in each major can be found here (http://catalog.uwm.edu/letters-science/approved-courses-research-requirement).

VII. The Minor
The College requires that students attain at least a 2.0 GPA in all credits in the minor attempted at UWM. In addition, students must attain a 2.0 GPA on all minor credits attempted, including any transfer work. Individual departments or programs may require higher GPAs for graduation.

Physics Major Requirements
Freshmen who enter with scores of 4 or 5 on the Physics Advanced Placement exam given by CEEB are given partial credit for the introductory courses.

Students who have a combined GPA of 2.500 or above in all mathematics and physics courses taken in the first two years will be approved for a major in physics. This requirement will be waived in those cases where students are able to show evidence of unusual circumstances.

The department offers two study options. The standard physics major is for students who seek a general physics degree. The physics major with astronomy emphasis is for students who wish to pursue their interest in astronomy. While the standard physics major generally is followed by graduate work in physics, the astronomy emphasis also enables students to pursue graduate work in physics. Both options require that students take at least 15 credits in advanced-level (numbered 300 and above) courses in residence at UWM. The College of Letters & Science requires that students attain at least a 2.0 GPA on all major credits attempted, including any transfer work. All students in the College are required to complete a research experience in their majors. Physics majors meet this requirement by successfully completing an upper-level, 3-credit laboratory course.

Select one of the following:

- **PHYSICS 219** Physics I: Calculus-Based, Studio Format
- **PHYSICS 220** Physics II: Calculus-Based, Studio Format

Option 2:

- **PHYSICS 209 & PHYSICS 214** Physics I (Calculus Treatment) and Lab Physics I (Calculus Treatment)
- **PHYSICS 210 & PHYSICS 215** Physics II (Calculus Treatment) and Lab Physics II (Calculus Treatment)
- **PHYSICS 309** Physics III: Modern Physics
- **PHYSICS 270** Introduction to Computational Physics
- **PHYSICS 370** Analytical and Numerical Methods in Physics
- **PHYSICS 317** Thermodynamics
- **PHYSICS 325** Optics

Select one of the following:

- **PHYSICS 406** Introduction to Infrared Microspectroscopy
- **PHYSICS 408** Experiments in Linear Electronics
- **PHYSICS 409** Modern Physics Laboratory
- **PHYSICS 670** Electron Microscopy Laboratory
- **PHYSICS 391** Undergraduate Research Participation

Selecting electives are encouraged (see below)

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASTRON 400</td>
<td>Astrophysics I</td>
<td>3</td>
</tr>
<tr>
<td>ASTRON 401</td>
<td>Astrophysics II</td>
<td>3</td>
</tr>
<tr>
<td>PHYSICS 305</td>
<td>Medical Physics</td>
<td>3</td>
</tr>
</tbody>
</table>

1. PHYSICS 219 and PHYSICS 220 are strongly recommended; however, PHYSICS 209/PHYSICS 214 and PHYSICS 210/PHYSICS 215 courses may be taken with the consent of the undergraduate advisor.
2. These courses are not offered every semester; check with the undergraduate advisor to plan for completing this requirement.
3. The research proposal must be approved by the undergraduate advisor and the Departmental Undergraduate Committee, and it must demonstrate clear pedagogical value. Unfocused laboratory internships are not acceptable.
4. Students who major in both physics and engineering are not required to take PHYSICS 442; however, it is recommended strongly that they do so.

Electives
No elective courses are required, but students are encouraged to select electives from Physics or Astronomy courses 300 level or above from the following list. Only the courses identified in the list below with the phrase "if not selected above" will be counted in the student’s major GPA.

- **PHYSICS 209 & PHYSICS 214** Physics I (Calculus Treatment) and Lab Physics I (Calculus Treatment)
- **PHYSICS 210 & PHYSICS 215** Physics II (Calculus Treatment) and Lab Physics II (Calculus Treatment)
- **PHYSICS 309** Physics III: Modern Physics
- **PHYSICS 270** Introduction to Computational Physics
- **PHYSICS 370** Analytical and Numerical Methods in Physics
- **PHYSICS 317** Thermodynamics
- **PHYSICS 325** Optics

Select one of the following:

- **PHYSICS 406** Introduction to Infrared Microspectroscopy
- **PHYSICS 408** Experiments in Linear Electronics
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</tr>
<tr>
<td>PHYSICS 305</td>
<td>Medical Physics</td>
<td>3</td>
</tr>
</tbody>
</table>
PHYSICS 306  Introduction to Biophysics  3
PHYSICS 351  Basics of Condensed Matter Physics  3
PHYSICS 370  Analytical and Numerical Methods in Physics (if not selected above)  3
PHYSICS 391  Undergraduate Research Participation  1-6
PHYSICS 406  Introduction to Infrared Microspectroscopy (if not selected above)  3
PHYSICS 408  Experiments in Linear Electronics (if not selected above)  3
PHYSICS 409  Modern Physics Laboratory (if not selected above)  3
PHYSICS 309  Physics III: Modern Physics  3
PHYSICS 515  Statistical Mechanics  3
PHYSICS 517  Special Relativity  3
PHYSICS 531  Principles of Quantum Mechanics I  3
PHYSICS 532  Principles of Quantum Mechanics II  3
PHYSICS 541  Elementary Particles  3
PHYSICS 551  Introduction to Solid State Physics I  3
PHYSICS 651  Introduction to Solid State Physics II  3
PHYSICS 670  Electron Microscopy Laboratory (if not selected above)  3

**Physics Major with Astronomy Emphasis**

A minimum of 55 credits in physics and astronomy courses, including:

<table>
<thead>
<tr>
<th>Code</th>
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<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Required</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Select one of the following options: 1</td>
<td></td>
<td></td>
</tr>
<tr>
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<td></td>
<td></td>
</tr>
<tr>
<td>PHYSICS 219</td>
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<td>PHYSICS 220</td>
<td>Physics II: Calculus-Based, Studio Format</td>
<td>3</td>
</tr>
<tr>
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<td></td>
</tr>
<tr>
<td>PHYSICS 209 &amp; PHYSICS 214</td>
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<td>3</td>
</tr>
<tr>
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<td>Physics II (Calculus Treatment) and Lab Physics II (Calculus Treatment)</td>
<td>3</td>
</tr>
<tr>
<td>PHYSICS 309</td>
<td>Physics III: Modern Physics</td>
<td>3</td>
</tr>
<tr>
<td>PHYSICS 270 or PHYSICS 370</td>
<td>Introduction to Computational Physics or Analytical and Numerical Methods in Physics</td>
<td>3</td>
</tr>
<tr>
<td>PHYSICS 325</td>
<td>Optics</td>
<td>4</td>
</tr>
<tr>
<td>PHYSICS 317</td>
<td>Thermodynamics</td>
<td>3</td>
</tr>
<tr>
<td>Select one of the following: 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PHYSICS 406</td>
<td>Introduction to Infrared Microspectroscopy</td>
<td>3</td>
</tr>
<tr>
<td>PHYSICS 408</td>
<td>Experiments in Linear Electronics</td>
<td></td>
</tr>
<tr>
<td>PHYSICS 409</td>
<td>Modern Physics Laboratory</td>
<td></td>
</tr>
<tr>
<td>PHYSICS 670</td>
<td>Electron Microscopy Laboratory</td>
<td></td>
</tr>
<tr>
<td>PHYSICS 391</td>
<td>Undergraduate Research Participation 3</td>
<td></td>
</tr>
<tr>
<td>PHYSICS 411</td>
<td>Mechanics</td>
<td>4</td>
</tr>
<tr>
<td>PHYSICS 420</td>
<td>Electricity and Magnetism I</td>
<td>3</td>
</tr>
<tr>
<td>PHYSICS 422</td>
<td>Electricity and Magnetism II</td>
<td>3</td>
</tr>
<tr>
<td>PHYSICS 441</td>
<td>Introduction to Quantum Mechanics I</td>
<td>4</td>
</tr>
<tr>
<td>PHYSICS 442</td>
<td>Introduction to Quantum Mechanics II</td>
<td>3</td>
</tr>
</tbody>
</table>

### Electives

Select 6 credits from the following:

- ASTRON 400  Astrophysics I  3
- ASTRON 401  Astrophysics II  3

**Recommended**

- Students are advised strongly to take the following courses as part of their electives:
  - CHEM 102  General Chemistry  3
  - CHEM 104  General Chemistry and Qualitative Analysis  3
  - COMMUN 103  Public Speaking  3
  - ENGLISH 206  Technical Writing  3

### Total Credits

55

1. PHYSICS 219 and PHYSICS 220 are strongly recommended; however, PHYSICS 209/PHYSICS 214 and PHYSICS 210/PHYSICS 215 courses may be taken with the consent of the undergraduate advisor.
2. These courses are not offered every semester; check with the undergraduate advisor to plan for completing this requirement.
3. The research proposal must be approved by the undergraduate advisor and the Departmental Undergraduate Committee, and it must demonstrate pedagogical value. Unfocused laboratory internships are not acceptable.

### Possible Course Substitutions for Students with Physics and Engineering Double Majors

Note: Students who major in both physics and engineering are not required to take PHYSICS 442; however, it is recommended strongly that they do so.

One of the following courses may be substituted for PHYSICS 270 or PHYSICS 370:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIV ENG 280</td>
<td>Computer Based Engineering Analysis</td>
<td>3</td>
</tr>
<tr>
<td>COMPSCI 151</td>
<td>Introduction to Scientific Programming in Fortran</td>
<td>3</td>
</tr>
<tr>
<td>COMPSCI 250</td>
<td>Introductory Computer Programming</td>
<td>3</td>
</tr>
</tbody>
</table>

The following course may be substituted for PHYSICS 317:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>MECHENG 301</td>
<td>Basic Engineering Thermodynamics</td>
<td>3</td>
</tr>
</tbody>
</table>

The combination of both of the following may substitute for PHYSICS 411:
Letters & Science Advising

The College of Letters and Science provides general academic advising for all students with a major in the College, particularly as it relates to campus’ general education requirements and the College’s degree requirements. We also provide specialized advising for pre-professional students (pre-med, pre-dental, pre-pharmacy, etc.) regardless if their major is in Letters and Science or not. Prospective students, including high school students and students seeking to transfer to a program in Letters and Science may also receive advising from our admissions counselors.

Upon admission, students are assigned an advisor in the College advising office. Academic advising is available Monday through Friday from 8:30 a.m. to 4:30 p.m. by appointment. Appointments outside of these times may be available and phone appointments are available for online students. The advising office (https://uwm.edu/letters-science/advising/contact-advising) is located on the first floor of Holton Hall. Current students should call (414) 229-4654 to schedule an appointment or use the Student Success Collaborative website (https://uwmilwaukee.campus.eab.com) to make an appointment with your assigned advisor; online scheduling is only available if you already have a Letters & Science advisor assigned to you. Prospective students should call (414) 229-7711 or email let-sci@uwm.edu.

When students declare a major, they will receive an additional faculty advisor located within the major department who will assist with requirements for that major. Students should read the "Declaration of Major" information on the website of the major that they are interested in. In some cases, the student will need to choose a faculty advisor as part of the declaration process.

All students are cautioned to consult their Letters & Science academic advisor AND their major advisor prior to each registration period to ensure they understand all requirements. Do not rely on pre-printed sample plans, as they are intended to be samples only and may not be right for your particular situation.

Honors in the College of Letters and Science

Dean's Honor List
GPA of 3.750 or above, earned on a full-time student’s GPA on 12 or more graded credits in a given semester.

Honors Degree and Honors Degree with Thesis
Granted to graduating seniors who complete Honors College requirements, as listed in the Honors College (http://catalog.uwm.edu/opportunities-resources/honors-college) section of this site.

Commencement Honors
Students with a cumulative GPA of 3.500 or above, based on a minimum of 40 graded UWM credits earned prior to the final semester, will receive all-university commencement honors and be awarded the traditional gold cord at the December or May Honors Convocation. In schools and colleges in which fewer than 15% of the traditional students have a 3.500 GPA, all-university honors will be awarded to approximately the top 15% of graduating students. A criterion GPA (not lower than 3.200) for this 15% will be calculated based on statistics from the previous comparable semester. Please note that for honors calculation, the GPA is not rounded and is truncated at the third decimal (e.g., 3.499).

Final Honors
Earned on a minimum of 60 graded UWM credits: Cum Laude - 3.500 or above; Magna Cum Laude - 3.650 or above; Summa Cum Laude - 3.800 or above.

Contact Information
Current Students contact the Department directly, physics-ugadvisor@uwm.edu
Prospective Students contact a Letters & Science Admissions Counselor at (414) 229-7711 or let-sci@uwm.edu
https://uwm.edu/physics/undergraduate/