Physics

Program Description
The Department of Physics offers graduate study leading to the M.S. and Ph.D. degrees. Advanced work may involve specialized training in the following areas: biophysics, computational physics, condensed matter, nanomaterials, physics education research, polymer physics, soft matter physics, and statistical mechanics.

Research and academic programs are tailored to meet individual needs and interests. New students are strongly urged to visit faculty members to discuss research opportunities soon after their arrival.

Admissions Requirements
The Department of Physics graduate program is open to all qualified graduates of universities and colleges of recognized standing.

Financial Assistance
Prospective students must apply to the Graduate School and be accepted in full or conditional status before being eligible for an assistantship in the Department of Physics.

Generally, graduate students are supported during the academic year by either teaching assistantships or research assistantships. The 2018-2019 academic year stipend is $18,500 for 9 months. Additional support during the summer is also possible. Graduate tuition (but not student fees) is fully waived for all teaching assistants and research assistants.

Research Equipment
NDSU’s Materials and Nanotechnology Center is located in the Research and Technology Park. The Center is equipped with two state-of-the-art wet labs, a synthesis lab, optical characterization facilities (optical/NIR fluorescence microscopy, laser-scanning confocal microscopy, and light scattering/reflectometry), and surface characterization facilities (nano-indentation and atomic-force microscopy). There are seven fume hoods in the lab space, as well as a number of synthesis tools, including a Beckman Coulter Optima L-80 XP Ultracentrifuge. We also have access to state-of-the-art chemical synthesis facilities in the Departments of Chemistry and Biochemistry and Coatings and Polymeric Materials, including a Photo Emissions Tech Model SS50AAA Solar Simulator equipped with a Keithley 2400 Series Source meter. NDSU’s Center for Computationally Assisted Science and Technology (CCAST) provides large-scale computing resources to NDSU users.

The Graduate Coordinator or Chair shall assign to each incoming graduate student a temporary advisor, who shall assist in the selection of courses. During the first semester, the student is expected to discuss potential projects for thesis research with faculty members. By the beginning of the second semester, the student must have a permanent research supervisor. By the end of the second semester, the student must have filed a plan of study, selected a thesis topic, and secured two additional faculty members for the Advisory Committee.
# Master of Science

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHYS 790</td>
<td>Graduate Seminar</td>
<td>1</td>
</tr>
<tr>
<td>PHYS 798</td>
<td>Master's Thesis</td>
<td>6-10</td>
</tr>
</tbody>
</table>

Each student must earn at least 30 graduate credits, numbered 601-798, of which:

- at least 10 credits are Physics courses numbered 601-689 or 700-789;
- at least 16 credits are didactic courses numbered 601-689 or 700-789;
- between 6 and 10 credits are PHYS 798 (Master's Thesis);
- at least one credit must be PHYS 790 Graduate Seminar.

Students are required to attend all seminars and colloquia.

# Accelerated Master of Science

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHYS 790</td>
<td>Graduate Seminar</td>
<td>1</td>
</tr>
</tbody>
</table>

Choose from the following:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHYS 611</td>
<td>Optics for Scientists &amp; Engineers</td>
<td>21</td>
</tr>
<tr>
<td>PHYS 611L</td>
<td>Optics for Scientists and Engineers Lab</td>
<td></td>
</tr>
<tr>
<td>PHYS 613</td>
<td>Lasers for Scientists and Engineers</td>
<td></td>
</tr>
<tr>
<td>PHYS 615</td>
<td>Elements of Photonics</td>
<td></td>
</tr>
<tr>
<td>PHYS 662</td>
<td>Thermal and Statistical Physics</td>
<td></td>
</tr>
<tr>
<td>PHYS 685</td>
<td>Quantum Mechanics I</td>
<td></td>
</tr>
<tr>
<td>PHYS 686</td>
<td>Quantum Mechanics II</td>
<td></td>
</tr>
<tr>
<td>PHYS 752</td>
<td>Mathematical Methods in Physics I</td>
<td></td>
</tr>
<tr>
<td>PHYS 758</td>
<td>Statistical Physics</td>
<td></td>
</tr>
<tr>
<td>PHYS 761</td>
<td>Electromagnetism</td>
<td></td>
</tr>
<tr>
<td>PHYS 771</td>
<td>Quantum Physics I</td>
<td></td>
</tr>
<tr>
<td>PHYS 781</td>
<td>Solid State Physics</td>
<td></td>
</tr>
<tr>
<td>PHYS 798</td>
<td>Master's Thesis</td>
<td>6-8</td>
</tr>
</tbody>
</table>

Students must meet all requirements of the Physics bachelor and master programs. For the master's degree, students must earn at least 30 graduate credits, numbered 601-798, with these conditions:

- Up to 15 credits from this list may count toward the bachelor program requirements. It is recommended that students take the 600-level of PHYS 462/662, 485/685, and 486/686 while fulfilling the requirements for the bachelor's degree.
- Between 6 and 8 credits are PHYS 798 (Master's Thesis), with the goal to publish a paper based on the thesis research, although this is not a requirement to graduate.
- At least one credit is PHYS 790 Graduate Seminar.

# Doctoral Degree

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHYS 752</td>
<td>Mathematical Methods in Physics I</td>
<td>16</td>
</tr>
<tr>
<td>PHYS 758</td>
<td>Statistical Physics</td>
<td></td>
</tr>
<tr>
<td>PHYS 761</td>
<td>Electromagnetism</td>
<td></td>
</tr>
<tr>
<td>PHYS 771</td>
<td>Quantum Physics I</td>
<td></td>
</tr>
<tr>
<td>PHYS 781</td>
<td>Solid State Physics</td>
<td></td>
</tr>
<tr>
<td>PHYS 790</td>
<td>Graduate Seminar</td>
<td></td>
</tr>
</tbody>
</table>

Letter-graded courses (no more than 12 cr in non-physics courses) | 27
Credits used to satisfy the requirements for the M.S. degree may be included in the total. Students are required to attend all seminars and colloquia.

**Comprehensive Examination**

By the end of their fourth semester, students:

- submit a report that summarizes their research results so far and details a research plan for the rest of their research work;
- give a talk about their research accomplishments and plans; and
- must pass an oral examination by the Advisory Committee to confirm doctoral candidacy.

Students who pass the comprehensive examination and, at the time of the exam, have completed 30 credits (16 of which are didactic) will earn a master’s degree and be eligible to participate in commencement that semester. Students should choose the Ph.D. + master’s option from the drop-down menu on the Doctoral Degree Plan of Study and on the Request to Schedule Examination. After students have passed the comprehensive examination, they should complete the Exit Survey and the Degree Application. A link to these items will be emailed to them by the Graduate School.

If the student fails the comprehensive examination, she/he will be given the opportunity to repeat the examination in the next semester (this examination can be repeated only once). Alternatively, the student may elect to work for a master’s degree instead.

Students should submit their doctoral thesis for examination at the end of their fourth year

**Dissertation Video**

Doctoral students are required to submit a three-minute video summarizing their dissertation research for a lay audience. The video should be produced, with guidance from the thesis supervisor, during the final semester of study and presented to the supervisory committee at the final defense.

For the comprehensive and final examinations, students must submit the appropriate forms to the Graduate School.

**Warren Christensen, Ph.D.**
Iowa State University, 2007
Postdoctoral: University of Maine, 2007-2009
Research Interests: Physics Education Research, Student Content Understanding, Curriculum Development

**Yongki Choi, Ph.D.**
The City University of New York, 2010
Postdoctoral: University of California Irvine, 2010-2014

**Andrew Croll, Ph.D.**
McMaster University, 2009
Postdoctoral: University of Massachusetts, 2008-2010
Research Interests: Polymers, Diblock Copolymers, Thin Films, Pattern Formation, Mechanics

**Alan R. Denton, Ph.D., Graduate Coordinator**
Cornell University, 1991
Postdoctoral: University of Guelph, 1991-94; Technical University of Vienna, 1994-95, Research Center Julich, 1996-98
Research Interests: Soft Condensed Matter Theory, Computational Physics

**Eric Hobbie, Ph.D.**
University of Minnesota, 1990
Research Interests: Nanotechnology, Nanoparticles, Polymers, Optics and Rheology

**Andrei Kryjevski, Ph.D.**
University of Washington, 2004
Research Interests: First-Principles Numerical Techniques for Fermi Systems, Electronic Structure of Nanoparticles

**Mila Kryjevskaya, Ph.D.**
University of Washington, 2008
Research Interest: Physics Education

**Sylvio May, Ph.D., Department Chair**
Friedrich-Schiller University, 1996
Research Interests: Physics of Lipid Membranes, Biophysics

**Orven Swenson, Ph.D.**
Air Force Institute of Technology, 1982
Research Interests: Laser Materials Processing, Optics Education

**Alexander J. Wagner, Ph.D.**
University of Oxford, 1997
Research Interests: Computational Soft Matter, Phase Separation, Diffusion, Interfaces Physics

**Emeritus**

**Ghazi Q. Hassoun, Ph.D.**
University of Minnesota, 1963
Postdoctoral: University of Michigan, 1963-65
Research Interests: Foundations of Quantum Mechanics

**Daniel M Kroll, Ph.D.**
University of Chicago, 1973
Research Interests: Theoretical and Computational Modeling of Complex Fluids and Biomembranes

**Charles A. Sawicki, Ph.D.**
Cornell University, 1975
Postdoctoral: Cornell University, 1975-79
Research Interests: Acoustics, Biophysics, Geophysics

**Mahendra K. Sinha, Ph.D.**
Pennsylvania State University, 1961
Postdoctoral: National Research Council (Ottawa), 1964-66
Research Interests: Field Emission and Field-Ion Microscopy

**Adjunct Faculty**

**Stuart Croll, Ph.D.**
University of Leeds, 1974
Research Interests: Weathering Durability, Film Formation, Internal Stresses In Films, Modern Art Conservation, and History of Paint Technology

**Eric M. Foard, Ph.D.**
North Dakota State University, 2013
Research Interests: Theoretical, Computational, Soft Matter, and Phase Separation Physics

**Kenneth Lepper, Ph.D.**
Oklahoma State University, 2001
Research Interests: Applied Solid State Physics (geologic materials) and Materials Characterization

**Konstantin Pokhodnya, Ph.D.**
Moscow Institute of Science and Technology, 1977
Research Interests: Materials, Thin Film Fabrication, Spintronics