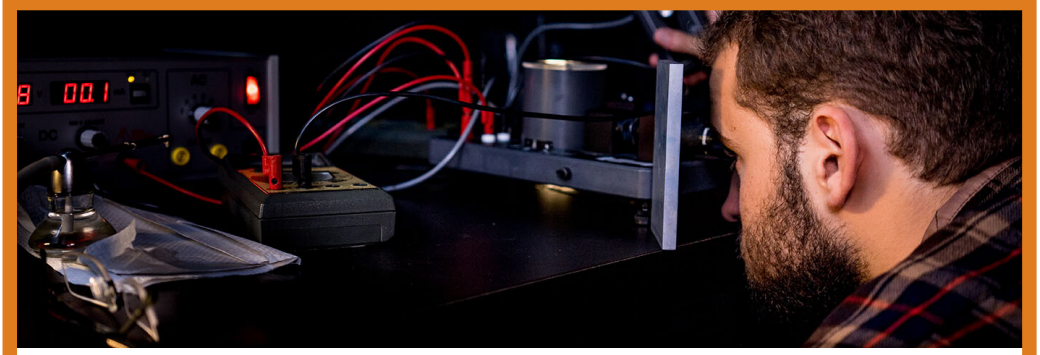
PHYSICS DEPARTMENT

Where high standards are only the beginning



Millersville University

Physics Student Handbook

Fall 2024

You can find us here: http://www.millersville.edu/physics/

FORWARD

This handbook has been prepared to provide information about the Millersville University Physics Department and its programs. It complements, but does not replace, the catalog and other official Millersville University documents. We plan to revise it yearly. If you find errors or have suggestions for changes in future versions, please bring them to the attention of the department secretary.

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INTRODUCTORY COMMENTS

About Millersville University

Millersville University is located in Lancaster County, an area rich in scenic beauty and historic sites. Recognized as the center of the Pennsylvania Dutch culture, Lancaster County also offers a wide range of cultural, recreational and career opportunities. Because the campus is within easy access of Philadelphia, Baltimore, Washington and New York City, Millersville students may additionally enjoy the benefits of those major cities.

Part of Pennsylvania's State System of Higher Education, Millersville University offers a diversified program of undergraduate and graduate studies in arts, sciences, business and education. Undergraduate degrees granted by Millersville University are the Bachelor of Arts, Bachelor of Science, Bachelor of Fine Arts, Bachelor of Science in Education, Bachelor of Science in Nursing and Associate of Arts and Associate of Science. Graduate level degrees offered are the Master of Arts, Master of Science, Master of Social Work and Master of Education. A limited amount of post-master's work is also available.

The student body numbers approximately 7500, over 70 percent are full time undergraduates; the rest are part time undergraduates and graduate students. Students may choose from a curriculum of more than 50 undergraduate programs taught by about 325 highly qualified faculty.

The 250-acre campus, like much of the nearby countryside, is reflective of efforts to preserve the past while planning for the future. Late 19th and 20th century buildings surround a fountain- sprayed campus lake. A student union building, modern residence halls, an auditorium, many well-equipped classroom buildings, a multipurpose gymnasium and an eleven-story library, as well as park-like grounds, are well maintained so that the environment for students is exceptionally comfortable.

The Study of Physics

Physics is a mathematical study that attempts to understand the physical universe. It addresses fundamental questions about the nature of matter and energy and the forces by which objects interact. Beginning with these basic principles and simple models, physicists build descriptions of atoms, organic material, stars and the origin of the universe. Physics also has an applied side: scientists and engineers use their understanding of physical principles to solve practical problems in such areas as product development, process control and instrumentation.

For some students, the study is undertaken in the liberal arts tradition. They are motivated to ask basic questions about themselves and their physical environment. From their studies they learn to think in a rigorous and orderly manner. They learn to create an understanding of their world using this thinking as a tool.

For many majors, Physics provides the necessary training for entering careers in research, engineering and teaching. Physics is also a valuable background for other interdisciplinary fields such as medicine, bio-engineering, law, computer systems analysis and technical writing. Further career opportunities have been generated by demands in industrial research and development, on hospital staffs and in national laboratories.

Today's world is a complex one characterized by constantly changing technologies. Physics graduates are well prepared to enter this world because they have begun to understand the laws that govern the way things work and the physical principles behind the laws. Products and technology change, but physical principles do not.

Faculty and Facilities

Millersville University has consistently ranked high among undergraduate institutions in the country in the number of enrolled physics majors. This enables the university to offer an exceptionally wide variety of upper level and special topics courses. Furthermore, all physics lectures, recitations, and laboratories are taught by experienced faculty, all of whom hold Ph.D. degrees. Physics majors at Millersville are each assigned a faculty member within the department who advises them on course work, research projects, graduate school selection and careers.

Caputo Hall and the Roddy Science Center house physics classrooms, laboratories, a student project room, a departmental library, machine shop equipment, and microcomputers. Majors have access to the departmental library and computers. The department's well-equipped laboratories include separate rooms for optics, electronics and advanced physics. They support teaching laboratories for introductory, intermediate and advanced work.

Academic Opportunities

As students progress through the physics program, their academic activities expand beyond the standard physics core. Every physics major does a research project, the best of which are selected for publication. At weekly seminars, majors hear visiting scientists, engineers, faculty and advanced students present the results of current research.

In addition, special topics courses in theoretical and applied physics are offered each semester, enabling students to explore subjects not ordinarily available in an undergraduate physics program. Local chapters of the Society of Physics Students and Sigma Pi Sigma, the national physics honor society, add yet another dimension to the physics program at Millersville.

For students seeking to further expand their academic experiences there are several options at Millersville. Those opportunities include special honors classes that are open to freshmen and sophomores. Juniors and seniors may participate in the departmental honors program. Departmental honors at graduation can be earned by submission of an accepted independent research project or thesis.

Students who wish to earn credit, salary and practical on-the-job experience may apply to the Cooperative Education Program. This is an optional learning experience that combines university studies with full or part-time work.

One measure of any undergraduate program is the quality of the schools that accept graduates for advanced study. Millersville physics majors have been admitted for graduate work at many excellent institutions such as Princeton and Rensselaer (physics), Massachusetts Institute of Technology (nuclear engineering, oceanography, mechanical engineering), Woods Hole Oceanographic Institute (physical oceanography), University of Pennsylvania (electrical engineering, bio-engineering, materials science), Pennsylvania State University (engineering science, nuclear engineering, bio-engineering), University of Virginia (electrical engineering), Brown University (physics), and the University of Delaware (electrical engineering, computer engineering, physics).

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C = Caputo Hall
R = Roddy Science Center

DEPARTMENT FACULTY

Full Time Faculty Members

DR. NATALIA M. DUSHKINA – Professor of Physics; B.S., University of Sofia, 1983; M.S., Ibid., 1984; Ph.D., Bulgarian Academy of Sciences, 1993. Joined staff in 2004.
Interests: Optics and holography, lasers, optical properties of thin-films, physics pedagogy.

DR. TARIQ H. GILANI – Associate Professor of Physics; B.S., University of the Punjab, 1986; M.S., Ibid., 1988; M.S., Quaid-I-Azam University, 1991; Ph.D., Kyoto University, 1997. Joined staff in 2002. Interests: Experimental condensed matter physics, electronic transport properties of materials, conducting polymers, lasers.

DR. MEHMET I. GOKSU – Associate Professor of Physics; B.S., Istanbul Technical University, 1991; Ph.D., Case Western Reserve University, 2002. Joined staff in 2007. Interests: Experimental solid state physics – low temperature physics, renewable energy and physics education projects.

DR. SEAN P. HENDRICK – Chairperson, Associate Professor of Physics; B.A., University of Virginia, 1994; Ph.D., North Carolina State University, 2003. Joined staff in 2005. Interests: Theoretical and observational astrophysics in the field of supernova explosions and their remnants.

DR. XIN LI – Assistant Professor joined the Department in August of 2012. She received her B.A. in Physics (2006) from Beijing Institute of Technology, her M.S. in Physics (2008), her M.S. in Electrical Engineering (2011) and her Ph.D. in Physics (2010) from Mississippi University. Interests: Research interests include singular optics, nano-photonics, computational electromagnetics, and sub-wavelength resolution in imaging.

DR. ZENAIDA E. S. UY - Professor of Physics; B.S., University of the Philippines, 1964; M.A., S.U.N.Y. at Stony Brook, 1969; Ph.D., Ibid., 1972. Joined staff in 1981. Interests: Theoretical high energy physics.

Emeritus Faculty

DR. PATRICK J. COONEY - Professor of Physics Emeritus (1980-2007); B.S., Fordham University, 1966; M.A. S.U.N.Y. at Stony Brook, 1968; Ph.D., Ibid. 1975. Interests: Accelerator-based atomic and molecular physics; musical acoustics; coherent optics and holography; laboratory applications of microcomputers; physics pedagogy.

DR. JOHN W. DOOLEY - Professor of Physics (1975-2011); A.B., Wabash College, 1963; Ph.D. Wayne State University, 1969. Interests: Ultrasonics, applied physics, "bench-top" experimental physics.

DR. JOSEPH W. GROSH, JR. - Professor of Physics Emeritus (1969-2002); B.S., Franklin & Marshall College,1957; M.A., University of Arizona, 1960; Ph.D., University of Utah, 1966. Interests: Electronics, microprocessors.

DR. CONRAD R. MIZIUMSKI - Professor of Physics Emeritus (1973-2004); B.A., University of California- Riverside, 1961; M.A., Ibid., 1979; Ph.D., Ibid., 1969. Interests: Measurement theory, foundations of quantum mechanics.

DR. MICHAEL J. NOLAN – Professor of Physics (1984-2018); B.S., University of Illinois, 1971; M.S., Ibid., 1974; Ph.D., University of Chicago, 1977. Joined staff in 1984. Interests: Condensed matter physics, statistical mechanics, thermodynamics, fluid mechanics, mathematical physics, computer simulations.

DR. CLIFTON W. PRICE - Professor of Physics Emeritus (1971-2005); B.S., University of Vermont, 1967; Ph.D., Brown University, 1971. Interests: Mathematical physics, astronomy, astrophysics.

OVERVIEW OF DEPARTMENT ACADEMIC PROGRAMS

The Department of Physics offers several programs leading to the baccalaureate degree with a major in physics. The course structure recommended by the department is essentially identical during the first two years of all programs so that a revision in a student's plan need not involve any loss of time.

The Bachelor of Science degree in Physics involves the greatest depth in physics and mathematics. This program prepares the student for employment in a technical position upon graduation and provides as well a solid foundation for entrance into a graduate program in physics.

The Bachelor of Science in Education program prepares students for a career in high school physics teaching. In addition to the necessary physics and mathematics courses that are comparable to those required of our B.A., the B.S.E. program also requires numerous education courses. Students interested in the B.S.E. program should consult the B.S.E. Blur Sheet and the College of Education and Human Services for current requirements.

We have a 4/2 program with Penn State University. A student studies four years at Millersville and earns a B.S. degree in Physics. After transferring to Penn State, the student earns a Masters degree in two years from the Department of Engineering Science and Mechanics. In practice, it is possible to complete this program in less than two years. Up to six undergraduate credits at the 400-level in physics or mathematics may be transferred as graduate credit toward the Masters degree at Penn State University. Summer re-search programs at Penn State University are also available and can generate graduate credit in this program. A student can finish the graduate portion of this program in a year and a half.

In 2014 the Physics Department and the Department of Materials Science and Engineering at the University of Delaware finalized a 3/2 program. In this program, the student spends three years at MU and two years at the University of Delaware. Upon completion of the requirements, the stu-dent is awarded a Bachelor of Arts in Physics from Millersville University and a Master’s degree in Material Science and Engineering from the University of Delaware.

In 2018, the state system ordered a moratorium on programs that did not have a certain number of degrees offered over a 5-year period. This has forced us to remove the B.A. program and the various options we previously offered. We are in the process of reviving them as part of the MDST (Multi-Disciplinary Studies) program. The classic B.A. degree, as well as the options for Computer Science, Polymer Chemistry, and Philosophy, will still be an option for students to pursue, just not in their previous form.

DESCRIPTION OF INDIVIDUAL PROGRAMS

Students majoring in physics are required to attain a grade of C- or better in MATH 161-211 and PHYS 231-232 before moving on to courses which have these courses as prerequisites.

Distance Learning (DL) courses are not accepted as laboratory prerequisites for any Millersville University physics courses.

Physics Major (B.S.): 120 s.h. minimum
45 s.h. in physics: 231, 232, 233, 266, 311, 321, 331, 334, 351, 352, 395, 451, 471, 492, 498; plus 6 credits including one 400 level physics course and either PHYS 312 or 322. Required related courses: CHEM 111, or CSCI 151; MATH 161, 211, 311, 322, 365.

Physics Major (B.S.Ed.): 125 s.h. minimum
Secondary Education Certi ication
36-37 s.h. in physics: 231, 232, 233, 266, 311, 317 or ESCI 241, 321, 334, 351, 352, 492, 498. Required related courses: CHEM 111, 112; MATH 161, 211, 311, 365. Professional Education: EDFN 211, 241, 330; EDSE 321, 340, 435, 461, 471; SPED 346.

SUMMARY OF THE 4/2 COOPERATIVE ENGINEERING PROGRAM

Dr. Tariq Gilani is coordinator of the Cooperative Engineering program. The following document describes the 4/2 Cooperative Engineering Programs. ***Further information regarding these programs is available from Dr. Gilani.***

I. Introduction

Many of the problems faced by our society today will be solved through the application of advanced technology from the physical sciences. Physics, which is a fundamental science, and engineering, which applies our fundamental knowledge, will undoubtedly play important roles as we seek solutions to our problems. For example physics shows not only how to use energy but also how to conserve it.

This approach has distinct advantages. By first obtaining a solid foundation in physics, students acquire a versatility that will serve them throughout life. A background in physics enables them to select from a wide range of career paths. Our graduates have chosen fields including engineering (civil, mechanical, electrical, and nuclear), nuclear medical technology, technical writing, and physics. For the student who continues in one of the engineering fields, his or her physics background provides a greater comprehension of the tools and techniques used by engineers. For the student who is unsure, the flexibility of the physics curriculum allows shifts from one curric-ulum to another without difficulty: an early decision on career or field of advanced study is not necessary.

The cooperative engineering approach effectively combines the breadth of a quality liberal arts program with the career-oriented training of the engineering curriculum.

In the 4/2 program, students finish their degree in physics at Millersville before streamlined admission to the two year master's degree program in the Penn State Graduate School of Engineering Science. Over the past five years, we have sent nine students to Penn State, all in the 4/2 program.

The 4/2 Program combines a Bachelor of Science in Physics with a Master of Science in Engineer-ing. In this program, the student spends 4 years at MU, earning a Bachelor of Science in Physics degree. Upon completion of the MU degree, the student enters the graduate program of the Penn-sylvania State University (Penn State) Engineering Science and Mechanics Graduate Department, as a Master's Degree candidate. The master's degree is designed for completion within two years. Since students may transfer up to six MU credits in physics or mathematics to the Penn State pro-gram, the time to the master's degree can be shortened by careful planning.

In addition to our 4/2 program with Penn State, in 2014 the Physics Department and the Department of Materials Science and Engineering at the University of Delaware finalized a 3/2 Program. In this program, the student spends three years at MU and two years at the University of Delaware. Upon completion of the require-ments, the student is awarded a Bachelor of Arts in Physics from Millersville University and a Master's degree in Materials Science and Engineering from the University of Delaware.

II. 4/2 Cooperative Engineering Program with the Pennsylvania State University

A. 4/2 graduate research in the Engineering Science and Mechanics Graduate Department is done in a wide variety of areas, in a wide spectrum of Penn State laboratories. Affiliated Engineering Research Laboratories include:

* Advanced Microscopy Lab
* Axial-Torsion Fatigue Lab
* Battery Lab
* Center for Innovative Sintered Products
* Center for Nanotechnology Education and Utilization
* Center for the Engineering of Electronic and Acoustic Materials
* Cleanroom and Corrosion Learning Lab
* Composite Manufacturing Technology Center
* Computational Material Science
* Corrosion Research Lab
* Data Mining and Neural Network Lab
* Engineering Nano Characterization Center
* Fourier Optics Lab
* Laboratory for Parallel Computational Mechanics
* Laser Laboratory
* Micro-Electro-Mechanical System
* Non-Linear Dynamics Lab
* Optoelectronics Lab
* Penn State Nanofabrication Facility and Electronic Materials/Processing Research Lab
* RF MEMS Sensors and Microwave Lab
* Semiconductor Spectroscopy
* Tribology/Materials Processing Lab
* Ultrasonics Research and Development Lab

B. Admission to the Penn State Program. Upon successful application and admission into the Penn State graduate program, Millersville students who successfully completed a Bachelor of Science degree in Physics from Millersville University (MU) may elect to transfer up to six (6) MU cred-its of 400 level courses in either physics or mathematics for graduate credit towards a Master of Science Degree in Engineering Science and Mechanics. These credits must be additional electives that were not applied towards the applicant's undergraduate degree, and must reflect a grade of "B" or better. Three of these credits may be earned by participating in summer research at Penn State while still an undergraduate.

III. Materials Science & Engineering - 3/2 Cooperative Program with University of Delaware

The field of Materials Science and Engineering encompasses the broad disciplines of physics, chemistry, biology, and engineering by providing a platform for multidisciplinary activities across these fields. It integrates the role of research and education to develop and prepare student for today's challenges while giving them the breadth, perspective, versatility, and vision to adapt to the changing environment of tomorrow. Millersville University and the University of Delaware have established a comprehensive dual degree program that allows students in 5 years to earn both a BA degree in Physics from Millersville University as well as a MS degree in Materials Science and Engineering from the University of Delaware This dual degree option allows undergraduate students at Millersville University to transfer 26 earned credits from the BA Physics degree program to the University of Delaware in order to meet the required
120 credits needed to earn the BA Physics degree. This in turn allows students to accumulate graduate credits that can be used towards both degree options.

For admission to this program the following minimum criteria will be applied:

- Must be student in the BA Physics degree program at Millersville University of Pennsylvania
- Completion of five semester or 94 credits of coursework of the baccalaureate degree program
- Cumulative GPA of 3.2 or higher
- GRE quantitative score of at least 155 and a combined score (quantitative + verbal) of at least 300
- Three excellent letters of recommendations from faculty or scholars

C. Course Requirements

NOTE: The following course listings for each program are based on requirements for students entering Fall 2023.

1. For all pre-engineering curricula:

a. Physics:	s.h.	
PHYS 231 Physics I with Calculus	5	
PHYS 232 Physics II with Calculus	5	
PHYS 233 Modern Theories of Waves/Particle PHYS	3	
266 Electronics	3	
PHYS 311 Mechanics I	3	
PHYS 321 Electromagnetic Fields I	3	
PHYS 334 Macroscopic/Thermodynamics PHYS	3	
351 Intermediate Laboratory I	1	
PHYS 492 Physics Research & Seminar	2	
PHYS 498 Physics Research & Seminar	1	(29)

b. Required related courses:

CHEM 111 Introductory Chemistry I	4	
CHEM 112 Introductory Chemistry II **or** CSCI 151	4	
Introduction to Programming for Data Science I		
MATH 161 Calculus I	4	
MATH 211 Calculus II	4	
MATH 311 Calculus III	4	
MATH 365 Differential Equations	3	(23)

c. General Education:

	3	
First Year Inquiry Seminar	9	
Social Sciences	9	
Humanities	3	
Speech	3	
English Composition	3	
Wellness	3	
Perspectives	3	
Upper Level Writing	3	(39)
Electives		

D. Transfer Requirements:

1. Overall QPA: 3.5

2. Departmental Recommendation

E. Special Considerations:

1. Because of the extensive requirements in the Dual Degree - 3/2 Program, careful planning of the student's course selection is important. SEE YOUR ADVISOR.

2. The student should consult the department chair regarding procedures for transfer.

V. Graduate School

Many of our majors choose to go on to graduate school either in Physics or a closely related engi-neering field such as Electrical Engineering or Mechanical Engineering. Any student interested in pursuing such a career should take courses leading to a B.S. degree in Physics. Depending on the particular field of study other courses not normally required should also be taken. For example, a student wishing to pursue a graduate career in Physics should take both PHYS 311 (Mechanics I) and PHYS 312 (Mechanics II) along with both PHYS 321 (Electromagnetic Fields I) and PHYS 322 (Electromagnetic Fields II).
A student interested in Electrical Engineering should take both PHYS 321 and 322 in addition to PHYS 360 (Linear Circuit Analysis). For Mechanical Engineering the relevant courses are both PHYS 311 and PHYS 312 along with a Strength of Materials course that can be arranged as an in-dependent study in Special Topics in Applied Physics (PHYS 496).

COOPERATIVE EDUCATION

The Cooperative Education Program in Physics is an optional arrangement whereby students com-bine practical on-the-job experience with their formal classroom instruction. After the freshman year, the coop student spends alternate semesters in college and in employment in an industrial or government facility. The Co-op Program is available to all physics majors in the B.S. programs who satisfy the criteria for participation. (For more information see the section in the University Undergraduate Catalog on Cooperative Education.)
Dr. Gilani is presently serving as coordinator of this program.

PHYSICS MINOR

There is a minor available in Physics for students who are **not** majoring in Physics.
The course requirements are:

Minor in Physics

PHYS	231	Physics I with Calculus	5 s.h
PHYS	232	Physics II with Calculus	5 s.h.
PHYS	233	Modern Theories of Waves & Particles	3 s.h.
PHY	334	Macroscopic Phenomena and Thermodynamics	3. s.h
PHYS	3xx	Physics 300 or 400 level elective	3 s.h.
			19 s.h.

Prerequisites for the Minor in Physics

MATH 161	Calculus I	4 s.h
MATH 211	Calculus II	4 s.h.
MATH 311	Calculus III	4 s.h.
		12 s.h.

Minor in Heliophysics and Space Weather

In addition to the physics minor, there is an academic Minor in Heliophysics and Space Weather offered by the Earth Sciences Department

PHYS 233	Modern Theories of Waves and Particles	3 s.h
ESCI 341	Atmospheric Thermodynamics*	3 s.h.
PHYS 334	Macroscopic Phenomena and Thermodynamics*	3 s.h.
PHYS 321	Electromagnetic Fields I	3. s.h
PHYS 322	Electromagnetic Fields II	3 s.h.
PHYS 3xx	Physics 300 or 400 level course	3 s.h.
ECSI 440	Space Weather and Environment	3 s.h.
*ONLY ONE OF THESE COURSES IS REQUIRED		18 s.h.

Recommended, but not required

PHYS 435	Statistical Mechanics	3 s.h

Prerequisites for the Minor in Physics

MATH 161	Calculus I	4 s.h
MATH 211	Calculus II	4 s.h.
MATH 311	Calculus III	4 s.h.
MATH 365	Ordinary Differential Equations	3 s.h.
ESCI 241	Meteorology	4 s.h.
ESCI 342	Atmospheric Dynamics I	3 s.h.
		22 s.h.

Minor in Mathematics

Many physics majors take enough math courses to qualify for a minor in math. At present, the requirements for the math minor are:

Required Mathematics Courses

MATH 161*	Calculus I	4 s.h.
MATH 211	Calculus II	4 s.h.
MATH 311	Calculus III	4 s.h.
MATH 322	Linear Algebra I	4 s.h.
MATH XXX	Elective	3 s.h.
MATH XXX	Elective	3 s.h.
		22 s.h.

* MATH 163 Honors Calculus I (5.0 s.h.) may be taken in place of MATH 161

Mathematics Electives

Choose 6.0 credit hours of mathematics electives at the 300 level or above in consultation with your advisor. Choose only courses that count toward the BA Mathematics major.

Statistics

MATH 335	Mathematical Statistics I
MATH 435	Mathematical Statistics II
MATH 535	Statistical Methods I

Algebra

MATH 422	Linear Algebra II
MATH 345	Abstract Algebra I
MATH 445	Abstract Algebra II

Geometry and Topology

MATH 353	Survey of Geometry
MATH 355	Transformational Geometry
MATH 457	Elementary Differential Geometry
MATH 483	Point-Set Topology

Analysis

MATH 464	Real Analysis I
MATH 465	Real Analysis II
MATH 566	Complex Variables

Applied Math

MATH 365	Ordinary Differential Equations
MATH 467	Partial Differential Equations
MATH 375	Numerical Analysis

Other *

MATH 310	Introduction to Mathematical Proof (W)
MATH 370	Operations Research
MATH 393	Number Theory
MATH 395	Introductory Combinatorics

* MATH 301 is counted as an appropriate perspectives (P) course but does not count for a required related mathematics course.

If you have satisfied the requirements and wish to graduate with a Minor in Mathematics, you must fill out an **Academic Minor Form** (obtained from the **Student Forms Center** link on the MU web site)and submit it to the Department of Mathematics.

PHYSICS DEPARTMENT COURSE OFFERINGS

Course Descriptions

PHYS 101: 3 s.h. Survey of Physics (G2)
An elementary treatment of fundamental concepts of classical and modern physics. Selected examples from classical mechanics, electromagnetism, thermodynamics, relativity and quantum mechanics. The solving of numerical problems is de-emphasized. 3 hours of lecture and discussion. No credit in block G2 for majors in the School of Science and Mathematics. Credit will be granted for only one of the courses: PHYS 101, PHYS 103 or PHYS 104. Prereq: MATH placement at the 100 level or above. Offered in fall, spring.

PHYS 103: 4 s.h. Elements of Physics (G2, L)
An elementary treatment of fundamental concepts of classical and modern physics. Selected examples from classical mechanics, electromagnetism, thermodynamics, relativity, and quantum mechanics. The solving of numerical problems is de-emphasized. 3 hours of lecture plus 2 hours of lab. No credit in block G2 for majors in the School of Science and Mathematics. Credit will be granted for only one of the courses: PHYS 101, PHYS 103 or PHYS 104. Prereq: MATH placement at the 100 level or above. Offered in fall, periodically in spring.

PHYS 117: 3 s.h. General Astronomy (G2)
Astronomy for a general audience; emphasis on the physical nature of the universe. Terrestrial astronomy, light, telescopes, spectra, stars, stellar evolution, galaxies, cosmology, the solar system. 3 hours of lecture and discussion. No credit in block G2 for majors in the School of Science and Mathematics. Offered in fall, spring.

PHYS 131: 4 s.h. Physics I with Algebra (G2, L)
An introductory algebra-based course. Fundamental laws and properties of matter, mechanics and heat. Problems dealing with these laws. 3 hours lecture, 1 hour recitation and 2 hours lab. Prereq: MATH 101 or MATH Placement Testing score sufficient for the student to enroll in MATH courses above MATH 110. Offered in fall, spring, summer.

PHYS 132: 4 s.h. Physics II with Algebra (G2, L)
Continuation of Physics 131. Fundamental laws and properties of electricity, magnetism, waves, sound, light, and radiation. 3 hours lecture, 1 hour recitation and 2 hours lab. Prereq: PHYS 131 or PHYS 231. Offered in fall, spring, summer.

PHYS 198: 1 s.h. Seminar In Physics
An overview of the history, practice, philosophy and unity of physics and its application to other disciplines, orienting beginning physics majors to the study of physics. Mandatory for, and only open to, physics majors in their freshman year. 1 hr. discussion. Offered in fall.

PHYS 205: 3 s.h. (G2, L) Musical Acoustics
Intended for musicians dealing with the physical nature of sound and sound sources and the relation of these to music and musical instruments. The use of mathematics is kept to a minimum. 2 hours lecture-recitation and 2 hours lab. Prereq: MUSI 112. Offered in spring.

PHYS 230H: 1 s.h. General Physics Seminar (G2)
The ideas of introductory physics in extended depth, in the language of calculus, using problems, laboratory exercises, readings and discussion. Grades of B- or better in both PHYS 231 and PHYS 230H will result in honors designation for the pair. The pair of courses counts as one entry in the science component of the curriculum record form and results in six hours of general education credit. Coreq: Concurrent registration in PHYS 231 or PHYS 232 required, and either good stand-ing in the Honors Program or a 3.35 QPA or permission of instructor. Offered in fall, spring.

PHYS 231: 5 s.h. Physics I with Calculus (G2, L)
An introductory course in classical physics dealing with mechanics, fluids, waves and thermodynamics. 3 hours lecture plus 1 hour of recitation and one 3-hour lab. Prereq: MATH 161. Offered in fall, spring, and summer.

PHYS 232: 5 s.h. Physics II with Calculus (G2, L)
Continuation of PHYS 231. An introductory course in classical physics dealing with electricity, magnetism and optics. 3 hours lecture plus 1 hour of recitation and one 3-hour lab. Prereq: PHYS 231. Coreq: MATH 211. Offered in spring, and summer.

PHYS 233: 3 s.h. Modern Theories of Waves and Particles
Selected topics from the areas of waves and optics, special relativity, an introduction to the concepts and development of modern physics and single particle quantum mechanics. 3 hours of lecture. Prereq: PHYS 232. Coreq: MATH 311. Offered in spring.

PHYS 266: 3 s.h. Electronics
The fundamentals of analog devices and their application to electronic circuits. Operational amplifiers, power supplies, semi-conductor devices, oscillators, and an introduction to integrated circuits. Two 3-hour labs per week. Prereq: PHYS 132 or 232. Coreq: MATH 161. Offered in spring.

PHYS 302: 3 s.h. Physics and the Evolution of Western Civilization (P)
The history of the mechanization of the world picture. A study of physics in the evolution of Western civilization and thought to the time of Newton, relating the impact of the Newtonian revolution on Western society and thought. Prereq: A physical science course. Offered infrequently.

PHYS 311: 3 s.h. Mechanics I
Lectures, problems, and demonstrations developing the fundamental principles and concepts of classical mechanics, including Newton's laws of motion in 3 dimensions, conservation laws, linear and non-linear oscillating systems, gravitation, and central force problems. 3 hours lecture. Prereq: PHYS 232. Coreq: MATH 365. Offered in fall of odd years.

PHYS 312: 3 s.h. Mechanics II
A continuation of PHYS 311. Includes classical analysis of rigid body motion, non-inertial frames of reference, Lagrangian and Hamiltonian dynamics, systems of coupled oscillators, plus special topics. 3 hours lecture. Prereq: PHYS 311. Offered in spring of even years.

PHYS 317: 3 s.h. Introduction to Astronomy and Astrophysics
An overview of astronomy and astrophysics for students majoring in the sciences or mathematics, emphasizing selected areas such as terrestrial astronomy, celestial mechanics, stellar evolution, cosmology and the solar system. 3 hours lecture. Prereq: A year of college- level physics and calculus. Offered in fall of even years.

PHYS 321: 3 s.h. Electromagnetic Fields I
Electrostatic and magnetic fields in vacuum and in dielectric and magnetic materials. Maxwell's equations are developed. 3 hours lecture. Prereq: PHYS 233, 334. Coreq: MATH 365. Offered in fall of even years.

PHYS 322: 3 s.h. Electromagnetic Fields II
Consequences of Maxwell's equations. Solutions to Laplace's equation, electromagnetic radiation and relativistic electrodynamics are discussed. 3 hours lecture. Prereq: PHYS 321. Offered in spring of odd years.

PHYS 331: 2 s.h. Fundamentals of Optics
Lab-based course in physical optics, including applications of geometrical optics such as image formation by mirrors and lenses, microscopy, reflection, refraction, and basic phenomena in wave and quantum optics such as interference, diffraction, color mixing and filtration, polarization, bire-fringence, absorption, dispersion, scattering, laser properties and laser application. 1 hr. lec., 3 hrs. lab. Prereq: PHYS 232 or PHYS 132 and MATH 211. Offered in fall.

PHYS 334: 3 s.h. Macroscopic Phenomena and Thermodynamics
Lectures, problems, and demonstrations which develop the basic ideas of classical continuum physics and the macroscopic behavior of solids, liquids, and gases, including an introduction to fluid dynamics, stress-strain relationships in solids, electric and magnetic properties of materials, phase transitions, superconductivity, and the classical laws of thermodynamics. 3 hours lecture and discussion. Prereq: PHYS 232. Coreq: MATH 311. Offered in spring of even years.

PHYS 351: 1 s.h.
Intermediate Physics Laboratory I
Selected experiments in classical and modern physics introducing a variety of experimental techniques. 3 hours of lab. Prereq: PHYS 233 and either PHYS 266 or CSCI 370. Offered in fall.

PHYS 352: 1 s.h.
Intermediate Physics Laboratory II
Continuation of PHYS 351. 3 hours of lab. Prereq: PHYS 351. Offered in spring.

PHYS 395: 3 s.h. Techniques in Mathematical Physics
Treatment of advanced mathematical techniques such as complex analysis, matrices, Fourier series, calculus of variations, special functions and integral transforms applied to selected areas of physics. Prereq: PHYS 233, MATH 365. Offered in spring of odd years.

PHYS 431: 3 s.h. Solid State Physics
Classical and quantum analyses of solid matter. Topics include crystal structure, the reciprocal lattice, and X-ray diffraction; mechanical properties-phonons; semi-classical analysis of electrical and magnetic properties of insulators and metals; electron band theory of metals, insulators and semiconductors. 3 hours lecture. Offered in spring periodically.

PHYS 435: 3 s.h. Statistical Mechanics
Lectures, problems, and computer simulations developing the fundamental principles of classical and quantum statistical mechanics. Subjects include probability theory, the foundations of ensemble development, and their application to classical, Fermi, and Bose systems. Of special interest is the phenomenology of phase transitions and the modern development of the renormalization group. Offered in spring periodically.

PHYS 451: 1 s.h. Advanced Physics Laboratory I
Selected experiments in classical and modern physics with opportunities to apply sophisticated techniques to extended experimental problems. 3 hours lab. Prereq: PHYS 352. Offered in fall.

PHYS 452: 1 s.h. Advanced Physics Laboratory II
Continuation of PHYS 451. 3 hours lab. Prereq: PHYS 451. Offered in spring.

PHYS 462: 3 s.h. Advanced Electronics
Microprocessor applications and interfacing, real-time programming. Topics are selected from computer design, control loops, phase-locked loops and communications. Two 3-hour labs. Prereq: PHYS 266, 365, or permission of instructor. Offered infrequently.

PHYS 471: 3 s.h. Quantum Mechanics
An introduction to formal quantum theory in terms of operators on a Hilbert space. Dirac notation is introduced and used in the solution of the eigenvalue problems for the harmonic oscillator and angular momentum by operator techniques. Other topics include the dynamics of a spin-1/2 particle, the addition of angular momentum, and perturbation theory. MATH 322, 365 or permission of instructor. Offered in fall.

PHYS 492: 2 s.h. Physics Research and Seminar
The first semester of an independent research experience supervised by a faculty mentor. Attendance at weekly seminars is also required. Prereq: PHYS 351. Offered in fall.

PHYS 495: 1-3 s.h. Special Topics in Physics
Lecture course in selected topics of current interest in physics such as nuclear structure, elementary particle physics, advanced quantum mechanics, plasma physics, general rel-ativity, nonlinear dynamics, Lie groups and their physics applications, statistical mechanics, con-densed matter physics, and biophysics. Permission of instructor. Offered infrequently.

PHYS 498: 1-3 s.h. Physics Research and Seminar/Independent Study
An independent research experience supervised by a faculty mentor. Attendance at the weekly seminars associated with PHYS 492 is also required. Prereq: PHYS 492 or permission of instructor. Offered in fall, spring.

COURSE SEQUENCES AND REQUIREMENTS

Aside from the First Year Inquiry Seminar (PHYS 198), the study of Physics at MU begins with our PHYS 231-232 sequence. This pair of courses are the prerequisites for almost all later courses, and the material in them is basic to all of physics. To successfully complete these courses, your math must be in good working order; you must have completed MATH 161 to begin the sequence. The language of calculus is used from the first day onward in your introductory Physics sequence. If you enter with a shaky math background you should take pre- calculus (MATH 160) before starting MATH 161; it is often a disaster to try to rush into MATH 161 if one is really not ready for it. The Math Department placement program will provide important information on which math course you should take first. In PHYS 231 you must be very comfortable with the concepts of calculus (function, limit, derivative, integral, etc.), although you will seldom have to do any really elaborate calculations. In PHYS 232 your skills at integration (especially) will be more fully exercised. *The Department has adopted a policy that you must achieve a grade of C- or better in MATH 161, MATH 211, PHYS 231 and PHYS232 before you may take courses that have one of these courses as a prerequisite.* Once you have completed PHYS 232 you can now enter a variety of physics courses.

There are several 300 level courses which will be taught on an alternating basis. For the Fall semester in odd numbered years, we will offer PHYS 311 along with our Perspective course PHYS 302, then PHYS 312 and PHYS 334 in the following Spring semester. For the Fall semester in even numbered years, we will offer PHYS 321 along with elective PHYS 317, and follow that with PHYS 322 and PHYS 395 in the Spring.

The intermediate and advanced lab courses (351, 352, 451, 452) form 4 semester sequence to be started (normally) in the fall semester of the junior year. 351 and 451 are offered only in the fall, while 352 and 452 are offered in the spring only. 351 is required of all physics majors.

One course in electronics (PHYS 266) is required of all B.S.and B.S.Ed. physics majors. It is offered only in the spring semester and must be taken after PHYS 232 and before PHYS 351. For most physics majors this means taking PHYS 266 in the same semester as PHYS 233. Four additional courses in electronics (PHYS 360, 365, 366, and 462) are available for interested students.

SUGGESTED ELECTIVES FROM DIFFERENT DEPARTMENTS

There are many different requirements for the various degrees. Advisors are often asked what other courses one should take; this clearly varies with the individual and their interests/plans. An obvious suggestion would be to take some economics or business courses if you plan to enter the business world; persons with a dual major or a minor will also have other related courses suggest themselves naturally. It might be suggested that you give some thought to not only "lifetime sports", but also to "lifetime interests"; this is the place to get a little background in music, art, history, etc. that will surely make your later life richer - do it now, though; once you graduate you will be too busy! On the more specific side, there are several math electives that will serve you well. Once you have completed Ordinary Differential Equations (MATH 365) you should take Partial Differential Equations (MATH 467). You also will find it valuable to have had some linear algebra (MATH 322), some statistics (MATH 235 or 335-435), and a good exposure to complex variables. You certainly should have some familiarity with computers (although a good high school experience may suffice); you could then take some numerical analysis courses or the like, depending on your interests. This is a good topic to pursue with your advisor.

THE CURRICULUM RECORD FORMS (CRFs)

("purple and blue curriculum sheets")

There are two CRFs that each student at MU must follow; one is green or beige and one is blue. The CRFs play a special role in your experience at MU. For each program within a major there is a separate blue CRF; the current versions are usually available at the Registrar's Office, and the CRFs are included for each Physics program at the end of this booklet. To complete a particular program, you must satisfy the requirements outlined on the sheet for that program. If you follow a particular program through continuously, you may satisfy the requirements on the CRF as they were when you entered, even if there are course requirement changes in your program during your stay at MU; if you wish, of course, you may fulfill the new requirements. If you transfer to another program or drop out for a semester or more, you must satisfy the requirements at the time of the transfer/reentry to graduate.

The green or beige sheet is the general education curriculum form and must be satisfied by all MU students. There are several parts to the green or beige CRF. On the front are the core and fundamentals blocks. Their regulations are found on the green or beige CRF and in the catalog. A Physics major will clearly have their block G2 satisfied by CHEM 111-112 and Math courses. Be sure not to leave the G1 and G3 blocks, as well as any other requirements, for your Jr.-Sr. years; try to take at least one course that can go in those blocks each semester. You also must satisfy your math, writing, and developmental blocks on the back of the green or beige sheet. There are some fairly confusing situations that can arise, and your advisor can often help you with these. On the blue CRF are the central courses in your program, the departmental and departmentally related courses. You should map out which semesters you will take these courses and record on your own blue and green or beige CRFs all of the courses you have taken each semester. This will help you decide what you should take next, and when it comes time to graduate it will enable you to be sure that all requirements have been satisfied.

Comment on Advisement: You will be assigned a departmental advisor once you are identified as a physics major. You must see your advisor before you register each semester to get your course schedule approved; this should NOT be the only time you come in to see your advisor - they are there to help!

INDIVIDUALIZED INSTRUCTION AND INDEPENDENT STUDY

Individualized Instruction

It is not unusual for a student to need a particular existing course to graduate on time and not be able to take it during a semester when it would be offered. It may be possible to take the course as individualized instruction, but this is subject to finding a suitable instructor and securing departmental and school approval. In this case, the student works with the instructor according to a mutually satisfactory schedule. The procedure would be to locate a suitable and willing instructor, contact the department chairperson for their approval, and then submit the form (see department secretary) to the school dean for approval (since this may involve overloads and the like, approval is not automatic). Once approved, the form is submitted to the Registrar.

Independent Study

This refers, in our case, to PHYS 498, which may be taken for 1 to 3 semester hour credits. It is taken when a student wants to pursue a subject not covered in an existing course. The procedure is similar to that outlined above under Individualized Instruction. All students take PHYS 498 as part of their senior research experience. However, students wishing to do something beyond their senior experience could take an additional PHYS 498 course either before or after their senior research.

SENIOR RESEARCH, SEMINAR, AND MAJOR FIELD ACHIEVEMENT TEST (MFAT)

A graduation requirement in all degrees is PHYS 492, Physics Research and Seminar, and PHYS 498, Independent Study/Research in Physics. These two courses are generally taken during your last two semesters on campus. During the first semester you will take PHYS 492. Working closely with your faculty research mentor, you will select a topic for your research project and then carry out the research required to complete your investigation, presenting preliminary results to your mentor and to the rest of the Physics Department on an ongoing basis. You will also take the Major Field Achievement Test (MFAT) in Physics. During the second semester in PHYS 498, taken as an independent study course, you will complete your research project and present your results to the Department in both oral and written form. While your grade in PHYS 498 will be assigned by your research mentor, your grade in PHYS 492 will be assigned by the entire Department based on the outcome of your research project and your performance on the MFAT.

FACULTY RESEARCH AREAS

DR. NATALIA M. DUSHKINA joined the Department in August of 2004. She received a M.S. in Quantum Electronics and Lasers and a M.S. in Physics Pedagogy from the University of Sofia (1984), and her Ph.D. from the Bulgarian Academy of Sciences (1993). She completed a post- doc at the University of Tokyo (1995-97) working on ultra-fast non-linear optics, and at the Mechanical Engineering Laboratory, Tsukuba, Japan (1997-99) in studies of optical properties of thin-films. She also has industrial experience working as a manager of the laboratory for laser applications at the Gem City Engineering Co., Ohio. Before coming to Millersville, Dr. Dushkina was teaching College Physics at Bowling Green State University, Ohio. She is co- author of a textbook on lasers and laser technologies and a handbook of optical metrology, has written 33 scientific and technical papers, and has one patent.

Her research interests include optical properties of thin films and nano-structures, color formation, holography, laser applications, and optical measurement techniques. These studies are based on physical phenomena such as interference, diffraction, total internal reflection, polarization of light, and use of concepts of classical and non-linear optics. She has an ongoing interest in physics pedagogy and educational research.

DR. TARIQ H. GILANI joined the Department in September of 2002. He received his B.S. from the University of the Punjab (1986), an M.S. from the University of Punjab (1988), an M.S. from Quaid-I-Azam University (1991), and his Ph.D. from Kyoto University (1997).

His Ph.D. work was on “Low-temperature Metallic Conduction in PF_6-doped Polypyrrole”. He has also done research on dc resistivity, resistivity anisotropy, magnetoresistance and the Hall effect, thermoelectric power, heat capacity, and electron spin resonance. Since then his interests have been in the transport properties of the materials, lasers, and optics. He also spent about 10 months in a postdoctoral position at Penn State University studying surface science. Presently his special interests are in conducting polymers and their applications.

DR. MEHMET I. GOKSU joined the Department in August of 2007. He received his B.S. from Istanbul Technical University (1991) and his Ph.D. from Case Western Reserve University (2002).

His research background is in low temperature physics, two-dimensional electron systems on a liquid helium surface. He has studied edgemagnetoplasmons, which propagate around the

perimeter of a two-dimensional array of charges. He is very interested in new ideas and directions. His research interests include quantum computing, edgemagnetoplasmons, and projects on physics education. He is currently working on projects on renewable energy.

DR. SEAN P. HENDRICK joined the Department in August of 2005. He received his B.A from the University of Virginia (1994) and his Ph.D. from North Carolina State University (2003).

His research area is theoretical and observational astrophysics in the field of supernova explosions and their remnants. He has studied X-ray and infrared emission from remnants with both archival and original observations of targets in the Magellanic Clouds using an array of satellites: ROSAT, ASCA, Chandra X-ray Observatory, XMM-Newton, and the Spitzer Space Telescope.

DR. XIN LI joined the Department in August of 2012. She received her B.A. in Physics (2006) from Beijing Institute of Technology, her M.S. in Physics (2008), her M.S. in Electrical Engineering (2011) and her Ph.D. in Physics (2010) from Mississippi State University.

Her research interests include singular optics, nano-photonics, computational electromagnetics, and sub-wavelength resolution in imaging. She is investigating energy flow patterns on a sub-wavelength scale of the electromagnetic radiation by an atomic source or small particle. Of particular interest are the effects of an embedding medium and the presence of interfaces on the spatial distribution of the energy flow.

DR. ZENAIDA E. S. UY joined the Department in 1981. She received her B.S. from the University of the Philippines (1964) and a M.A. (1969) and Ph.D. (1972) from the State University of New York at Stony Brook.

She is a theoretical particle physicist. Her field is electroweak interactions and she has published papers on neutral kaon decays.

DEPARTMENTAL HONORS

Outstanding students majoring in physics may pursue Departmental Honors during their senior year. Participation in the Departmental Honors Program is highly selective and offers students in each of our major programs an opportunity to strengthen their background in physics while working closely with a faculty mentor on an extended research project. General information on Departmental Honors is found in the Academic Policies section of the University's catalog. Specific requirements for Honors in each of our major programs are as follows.

To be admitted to this program, one must have departmental approval and an overall QPA of 3.0 in the major courses. Students who aspire to Departmental Honors must declare their intentions at the start of PHYS 492. A high level of achievement in both PHYS 492 and PHYS 498 is required for Departmental Honors.

An additional requirement for the program is:

Honors in Physics will require, in addition to the core, that the full two semester sequence be completed in both Electromagnetic Fields (PHYS 321-322) and Mechanics (PHYS 311-312).

Students interested in graduating with Departmental Honors should discuss their plans with the Department Chairperson prior to the start of their senior year.

STUDENT ASSISTANTS AND TUTORING

Because we have no graduate students there are plenty of opportunities for students to gain experience and earn money by helping around the department. Typical jobs might include setting up and taking down lab equipment, repairing equipment, and working on special projects and outside contracts. The department is limited by money available for student hours, but these usually are sufficient; interested students should see a faculty member or the chairperson.

Students should also be aware of the benefits available through tutoring their fellow students. Most have found this a very good way to really learn some physics as well as pick up some income. The formal tutoring service is run from Adams House, and interested students should contact the people there for more information. You generally have to get a faculty member to sign a form indicating that they feel you are qualified to tutor a particular course. This program is being modified and its format may change.

SOCIETY OF PHYSICS STUDENTS

The Department has a Chapter of SPS (The Society of Physics Student) which is open to all students. This group meets and carries out various activities, including trips, outside speakers, physics films, picnics, and the like. Dr. Sean Hendrick is the current advisor. The Department also has a chapter of the Physics Honors Society, Sigma Pi Sigma (ΣΠΣ), to which qualified students are initiated each year. Please look for notices of meetings and be active; the success of this group depends on having a strong nucleus of interested and involved members.

DEPARTMENTAL/DIVISIONAL AWARDS

There are several annual awards (beyond the University-wide ones) for which you are eligible. (See catalog for more information.)

1. Henry Franklin Bitner Science Prizes - to best qualified seniors; one for biological sciences, one for physical sciences.

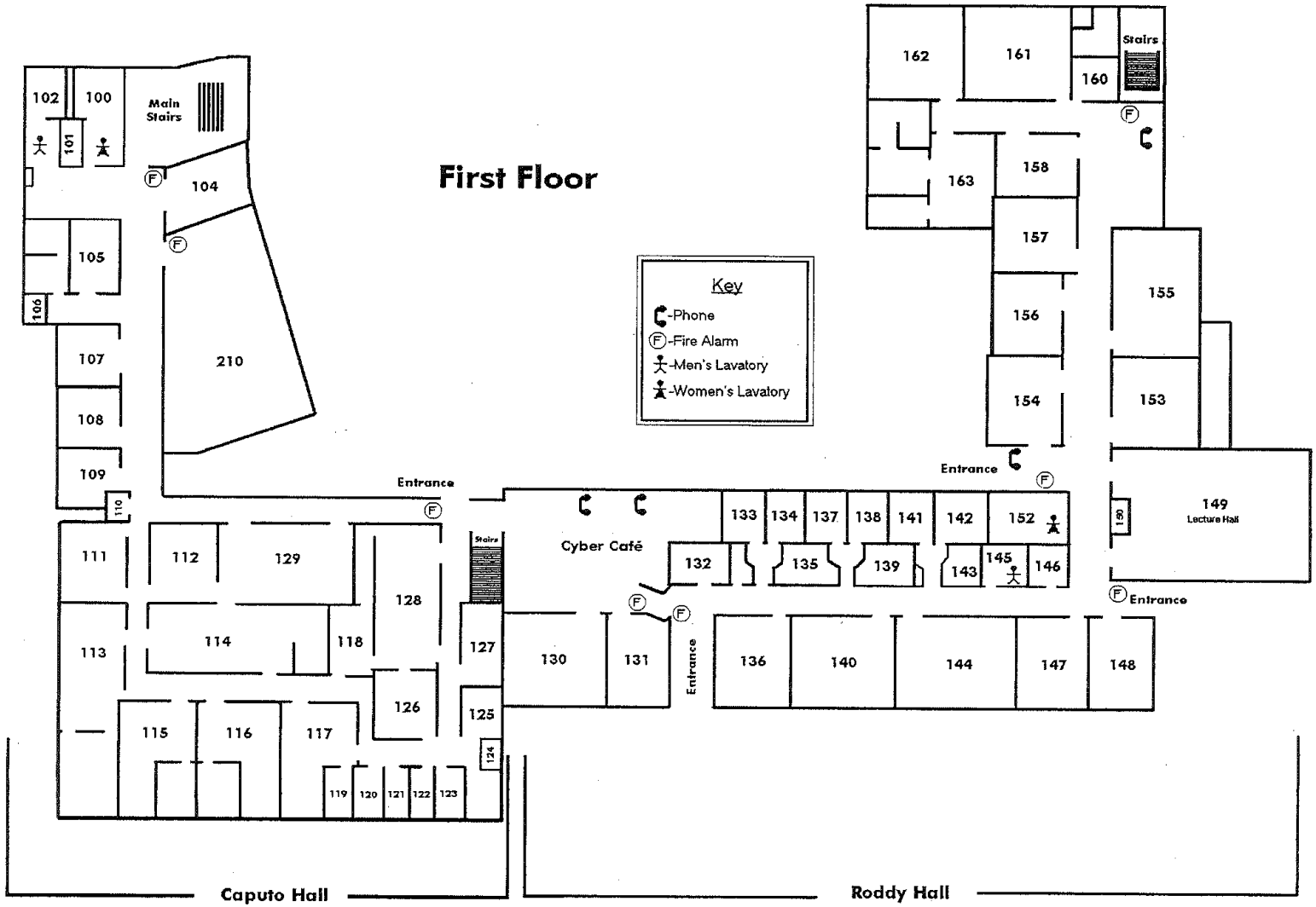
2. The Daniel G. Engle Scholarship - junior science major; based on scholarship and service to University and community. Professor Engle was one of the original members of the Physics Department.

3. George F. Stauffer Scholarship - sophomore or junior in the physical sciences. Professor Stauffer taught in the Earth Sciences Department.

4. The John A. Van Horn Award for Applied Physics - senior physics major. Dr. Van Horn was a member of the MU Physics Department and helped design the first electric watch for Hamilton.

CAREERS IN PHYSICS

Students graduating from MU in Physics have a number of choices; the American Institute of Physics (AIP) has a number of publications on this subject and provides other valuable services. If you are interested in further information, please speak with your advisor.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-Fire Alarm
-Men's Lavatory
-Women's Lavatory
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Stairs
Entrance
Cyber Café
Lecture Hall
Caputo Hall
Roddy Hall
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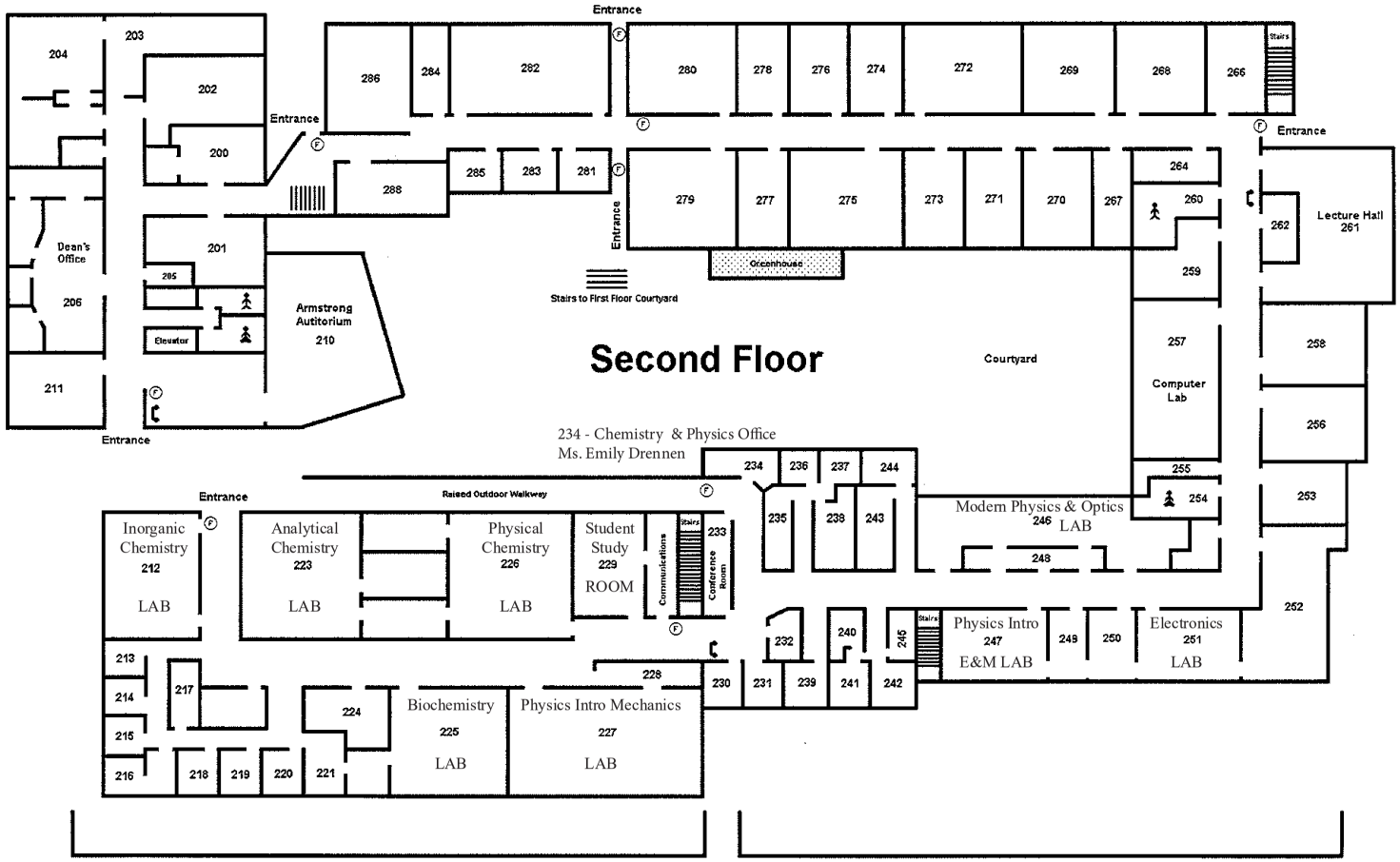


Caputo Hall

Offices
213- Dr. Rajaseelan
214- Dr. Albert
215- Dr. Rickard

Research Rooms
216- Dr. Rickard
217- Dr. Schiza
221- Dr. Mullen Davis
222- Dr. Rajaseelan

Offices
218 - Dr. Mullen Davis
219 - Dr. Schiza
220 - Prof. Sipe

Roddy Hall

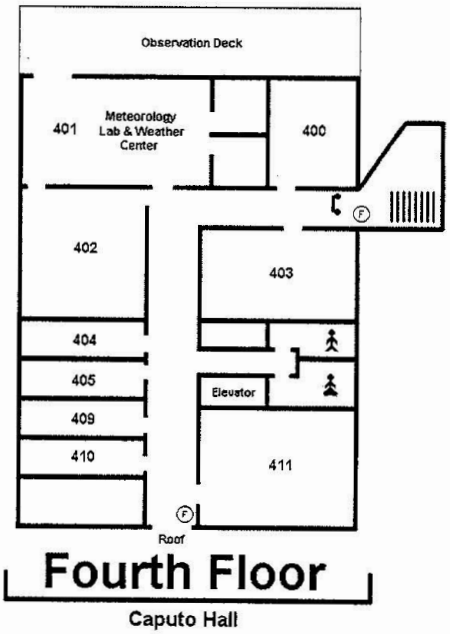
Offices
230- Dr. Cooke
231- Ms. Rebman
234- Dr. Manning
236- Dr. Gilani
237- Dr. Dushkina
239 -Dr. Hendrick
241- Dr. Goksu
242- Dr. Li

Research Rooms
232- Dr. Hendrick
235- Dr. Gilani
238- Dr. Dushkina
240- Dr. Gosku
243- Dr. Uy
249- Dr. Li

Laboratory Technician
252- Mr. Reinfried

245- Foucault Pendulum

250- Student Study Room



Offices
317 - Dr. Baker
318-
320 - Dr. Elioff
321 - Dr. Mbindyo
323 - Dr. Kennedy
325 - Dr. Miller

Research Rooms
315 - Dr. Mbindyo
316 - Dr. Baker
319 - Dr. Kennedy
322 -
324 - Dr. Miller
326 -

Laboratory Technician
330B - Mr. Nolte

Effective Fall Semester, 2018

MILLERSVILLE UNIVERSITY

General Education Curriculum Guide *(Purple Sheet)*

Student Name:_____ **Student I.D. #**_____

Critical Thinking Across the Liberal Arts (G1-G3)

General Guidelines:

- Only approved General Education (GenEd) courses may be used.
- Courses must be taken from at least two departments within each G1, G2, and G3 block.
- No more than two courses can be taken from any one department throughout the G1, G2, and G3 blocks.
- At least three courses taken throughout blocks G1, G2 &/or G3 must be at the 200 level or above.
- Up to six "Required Related" courses may be counted toward GenEd requirements.
- Courses from the primary major may not fulfill the G1, G2, and G3 blocks; courses from a minor or secondary major may fulfill these blocks.

G1. Humanities and Fine Arts: Three courses minimum totaling at least 9 credit hours.

G1 courses typically occur within the following departments: Art, Communications & Theatre, English, Foreign Language (which includes HUMN courses), Music or Philosophy. Students majoring in a Humanities & Fine Arts department may not count courses from the major department in this block.

Subject/Course#	Course Title	Cr. Hrs.	Grade
1.			
2.			
3.			

G2. Science and Mathematics: Three courses minimum totaling at least 9 credit hours.

G2 courses typically occur within the following departments: Biology, Chemistry, Computer Science, Earth Sciences, Mathematics, Nursing or Physics. Students majoring in a Science or Mathematics department may not count courses from the major department in this block.

Additional Guidelines:

- At least two courses must be taken from the "natural sciences": Biology, Chemistry, Earth Sciences and Physics. This can be two courses from any one of these departments **OR** one course from any two of these departments.
- One course taken within the G2 block must be a Lab course.

Subject/Course#	Course Title	Cr. Hrs.	Grade	✓ 2 from Natural Sci.	✓ 1 Lab Course
1.					
2.					
3.					

G3. Social Sciences: Three courses minimum totaling at least 9 credit hours.

G3 courses typically occur within the following departments: African-American Studies, Anthropology, Business Administration, Economics, Geography, Government, History, International Studies, Occupational Safety & Environmental Health, Psychology, Sociology, Social Work/Gerontology, or Women's Studies. Students majoring in the Social Sciences areas may not count courses from their major department in this block.

Subject/Course#	Course Title	Cr. Hrs.	Grade
1.			
2.			
3.			

Additional General Education Requirements

Foundations for Lifelong Learning (4 courses minimum 12 credit hours)

This category requires: **1. ENGL 110, 2. COMM 100, 3. GenEd (G2) approved Mathematics course (MATH 1XX), and 4. Advanced Writing (AW) course (ENGL 311, 312, 313, 316, 318, or 319).**

Guidelines:

- ENGL 110 must be completed with a grade of C- or better.
- COMM 100 must be completed with a grade of C- or better.
- The upper level writing (AW) course has a prerequisite of ENGL 110 (C- or better) and a minimum of 60 credit hours completed. Many majors recommend or require a specific AW course. Check the catalog for further details.
- G2 Math course must be different from that used towards the G2 block in the Liberal Arts Core.

Subject/Course#	Course Title	Cr. Hrs.	Grade
1. ENGL 110	English Composition	3.0	
2. COMM 100	Fundamentals of Speech	3.0	
3. MATH			
4. ENGL 31X			

Connections & Exploration Courses (minimum 9 credit hours)

Guidelines/Prerequisites:

1. **First-Year Inquiry (FYI) Seminar – UNIV 103 (3 credit hours) or Open Elective (3 credit hours)**
   - Open electives must be 100 level or above and must be taken outside of primary major.
   - For BSE students, required professional education courses **cannot** count as open electives.
2. **Perspectives (P) Course (3 credit hours)**
   - May be satisfied with approved courses from the major, the minor, the required related area, or general electives.
   - ENGL 110 and COMM 100 completed with grades of C- or better.
   - Minimum of 60 credit hours completed.
3. **Wellness/Health Education course (3 credit hours)**
   - Any WELL 175 course will fulfill this requirement.
   - Early Childhood Education or Early Childhood/Special Education majors are required to take WELL 240.

Subject/Course#	Course Title	Cr. Hrs.	Grade
1.			
2.			
3.			

Cultural Diversity & Community (D) Course

- May be satisfied with approved courses from the GenEd requirements (including Perspectives), the major, the minor, the required related area, or general electives.

Subject/Course#	Course Title	Cr. Hrs.	Grade
1.			

Writing Intensive (W) Courses (3 courses)

Guidelines/Prerequisites:

- May be satisfied with approved courses from the GenEd requirements, the major, the minor, the required related area, or general electives.
- ENGL 110 must be completed with a grade of C- or better.

Subject/Course#	Course Title	Cr. Hrs.	Grade
1.			
2.			
3.			

Developmental Courses (COMM 010, EDUC 090, ENGL 010, MATH 090)

These do not count toward the 120 credit hours required for graduation.

Revised by L. Lynn Marquez 8/17/2018

MILLERSVILLE UNIVERSITY

Student Name:_____ Student I.D.#_____

DEGREE: BS
MAJOR: PHYS
OPTION:

MAJOR REQUIREMENTS FOR A BS DEGREE IN PHYSICS

Total credit hours required: 120.0 minimum

REQUIREMENTS AND POLICIES FOR THE BS PHYSICS MAJOR

A. Policies for Admission to the Major

1. New students (freshmen and transfers) must be admitted to the Physics major by the Office of Admissions upon admission to the University.
2. Admission into the Physics major from other departments is upon approval of the chairperson of the Department.
3. Non-degree and continuing education students must be admitted to the Physics major by the Office of Admissions.

B. Policies for Retention in the Major

1. University requirements for retention.

C. Policies for Completion of the Major

1. Completion of all University curricular requirements.
2. Students majoring in Physics are required to attain a C- or better in MATH 161 - 211 and PHYS 231 - 232 before taking courses which have these courses as prerequisites.

Note to the student: *This form is provided as a guide. It is your responsibility to consult regularly with your advisor to be aware of changes and curriculum details which are not incorporated on this form.*

MAJOR SEQUENCE AND DEGREE REQUIREMENTS

Major: **BS PHYS**
Option:
Major Field Requirements: **45.0 credits**
Other Requirements: **27.0 credits**

When applicable, up to six of the **REQUIRED RELATED** courses may be credited toward the Liberal Arts Core subject to normal distribution rules.

REQUIRED PHYSICS COURSES (39.0 credits)

Course No.	Short Title	C.H.	Grade
PHYS 231	Physics I with Calculus	5.0	
PHYS 232	Physics II with Calculus	5.0	
PHYS 233	Modern Theory Waves/Particles	3.0	
PHYS 266	Electronics	3.0	
PHYS 311	Mechanics I	3.0	
PHYS 321	Electromagnetic Fields I	3.0	
PHYS 331	Fundamentals of Optics	2.0	
PHYS 334	Macro/Thermodynamics	3.0	
PHYS 351	Intermediate Physics Lab I	1.0	
PHYS 352	Intermediate Physics Lab II	1.0	
PHYS 395	Techniques in Math Physics	3.0	
PHYS 451	Advanced Physics Lab I	1.0	
PHYS 492	Research & Seminar	2.0	
PHYS 471	Quantum Mechanics	3.0	
PHYS 498	Independent Study/Research	1.0	

PHYSICS ELECTIVES (6.0 credits)

Choose one of the following:

PHYS 312	Mechanics II	3.0	
PHYS 322	Electromagnetic Fields II	3.0	

Choose one of the following:

PHYS 431	Solid-State Physics	3.0	
PHYS 435	Statistical Mechanics	3.0	
PHYS 462	Advanced Electronics	3.0	
PHYS 498	Independent Study/Research	3.0	

REQUIRED RELATED (27.0 credits)

Chemistry & Computer Science (8.0 credits)

Course No.	Short Title	C.H.	Grade
CHEM 111	Introductory Chemistry I	4.0	
	Choose ONE:		
CHEM 112	Introductory Chemistry II	4.0	
CSCI 151	Intro to Prog. Data Science	4.0	

Mathematics (19.0 credits)

MATH 161	Calculus I	4.0	
MATH 211	Calculus II	4.0	
MATH 311	Calculus III	4.0	
MATH 322	Linear Algebra I	4.0	
MATH 365	Ord. Differential Equations	3.0	

BACHELOR OF SCIENCE IN PHYSICS

SAMPLE PROGRAM (120 s.h. minimum)

FIRST SEMESTER

UNIV 103	Inquiry Seminar	3.0
MATH 161	Calculus I	4.0
CHEM 111	Intro Chemistry I	4.0
ENGL 110	English Composition	3.0
	TOTAL S.H.	14.0

SECOND SEMESTER

PHYS 231	Physics I w/Calculus	5.0
MATH 211	Calculus II	4.0
CHEM 112	Intro. Chemistry II **or** CSCI 151	4.0
COMM 100	Fund. Of Speech	3.0
	TOTAL S.H.	16.0

THIRD SEMESTER

PHYS 232	Physics II w/Calculus	5.0
MATH 311	Calculus III	4.0
WELL 175	Wellness	3.0
____ ____	Hum./Soc. Science #1	3.0
	TOTAL S.H.	15.0

FOURTH SEMESTER

PHYS 233	Theory Wave/Particles	3.0
PHYS 266	Electronics	3.0
PHYS 334	Macro/Thermodynamic	3.0
MATH 365	Ord. Diff. Equations	3.0
____ ____	Hum./Soc. Science #2	3.0
	TOTAL S.H.	15.0

FIFTH SEMESTER

PHYS 331	Optics	2.0
PHYS 351	Intermediate Lab I	1.0
PHYS 311	Mechanics I	3.0
MATH 322	Linear Algebra	3.0
____ ____	Perspectives Course	3.0
____ ____	Elective	3.0
	TOTAL S.H.	15.0

SIXTH SEMESTER

*PHYS 312	Mechanics II	3.0
PHYS 321	Electro Mag. Fields I	3.0
PHYS 352	Intermediate Lab II	1.0
PHYS 395	Tech of Math Physics	3.0
WRIT 319	Science Writing	3.0
____ ____	Hum./Soc. Science #3	3.0
	TOTAL S.H.	16.0

SEVENTH SEMESTER

* PHYS 322	Electro Mag. Fields II	3.0
PHYS 451	Advanced Lab I	1.0
PHYS 471	Quantum Mechanics	3.0
**PHYS 4XX	Req. Physics Elective	3.0
PHYS 492	Research & Seminar	2.0
____ ___	Hum./Soc. Science #4	3.0
	TOTAL S.H.	15.0

EIGHTH SEMESTER

PHYS 498	Ind. Study/Research	1.0
**PHYS 4XX	Req. Physics Elective	3.0
____ ____	Hum./Soc. Science #5	3.0
____ ____	Hum./Soc. Science #6	3.0
____ ____	Elective	3.0
	TOTAL S.H.	16.0

COMMENTS, NOTES OR RECOMMENDATIONS

This represents a close-to-minimum program for this major. Most students take additional free electives.

* Choose one of either PHYS 312 or PHYS 322. For students interested in pursuing a graduate career in physics, we strongly recommend taking both courses.

** Choose one 400 level physics elective from the list of approved courses—see Physics B.S. blue sheet.

1.In practice expect to select the 4 required writing (W) courses and the 1 required diversity (D) courses from the 6 Humanities/Social Science courses.

MILLERSVILLE UNIVERSITY

Student Name:_____ Student I.D.#_____

DEGREE: BSE
MAJOR: PHYS
OPTION:

MAJOR REQUIREMENTS FOR A BSE DEGREE IN PHYSICS

Total credit hours required: 125.0 minimum

REQUIREMENTS AND POLICIES FOR THE BSE PHYSICS MAJOR

A. Policies for Admission to the Major

1. New students (freshmen and transfers) must be admitted to the Physics major by the Office of Admissions upon admission to the University.
2. Admission into the Physics major from other departments is upon approval of the chairperson of the Department.
3. Non-degree and continuing education students must be admitted to the Physics major by the Office of Admissions.

B. Policies for Retention in the Major

1. University requirements for retention.

C. Policies for Completion of the Major

1. Completion of all University curricular requirements.
2. Students majoring in Physics are required to attain a C- or better in MATH 161 - 211 and PHYS 231 - 232 before taking courses which have these courses as prerequisites.

D. Admission to Advanced Professional Studies and Certification (Education Majors)

All students enrolled in teacher preparation programs must be admitted to Advanced Professional Studies and meet Pennsylvania State requirements and university requirements prior to being enrolled in their initial Advanced Professional Studies course. Students must meet additional Pennsylvania State requirements in order to be certified. A listing of Advanced Professional Studies courses and requirements is available in each department office, the Field Services office, and on the Field Services website.

Note to the student: *This form is provided as a guide. It is your responsibility to consult regularly with your advisor to be aware of changes and curriculum details which are not incorporated on this form.*

MAJOR SEQUENCE AND DEGREE REQUIREMENTS

Major: **BSE PHYSICS**
Option:
Major Field Requirements: **33.0 - 34.0 credits**
Other Requirements: **56.0 credits**

When applicable, up to six of the **REQUIRED RELATED** courses may be credited toward the Liberal Arts Core subject to normal distribution rules.

Course No.	Short Title	C.H.	Grade
REQUIRED PHYSICS COURSES (30.0 credits)			
PHYS 231	Physics I with Calculus	5.0	
PHYS 232	Physics II with Calculus	5.0	
PHYS 233	Modern Theory Waves/Particles	3.0	
PHYS 266	Electronics	3.0	
PHYS 311	Mechanics I	3.0	
PHYS 321	Electromagnetic Fields I	3.0	
PHYS 334	Macro/Thermodynamics	3.0	
PHYS 351	Intermediate Physics Lab I	1.0	
PHYS 352	Intermediate Physics Lab II	1.0	
PHYS 492	Research & Seminar	2.0	
PHYS 498	Independent Study/Research	1.0	
PHYSICS ELECTIVES (3.0 - 4.0 credits)			
PHYS 317	Intro Astronomy/Astrophysics	3.0	
--OR--			
ESCI 241	Meteorology	4.0	
PROFESSIONAL EDUCATION (33.0 credits)			
EDFN 211	Foundations Modern Education	3.0	
EDFN 241	Psych Foundations of Teaching	3.0	
EDFN 330	Instruction Technical Design	3.0	
EDSE 321	Issues in Second Education	3.0	
EDSE 435	Teaching Science	3.0	
EDSE 340	Content Area Literacy	3.0	
SPED 346	Sec. Students w/Disabilities	3.0	
EDSE 471	Differentiating Instruction	3.0	
EDSE 461	Student Teaching	9.0	

Course No.	Short Title	C.H.	Grade
REQUIRED RELATED (23.0 credits)			
Mathematics (15.0 credits)			
MATH 161	Calculus I	4.0	
MATH 211	Calculus II	4.0	
MATH 311	Calculus III	4.0	
MATH 365	Ord. Differential Equations	3.0	
Chemistry & Computer Science (8.0 credits)			
CHEM 111	Introductory Chemistry I	4.0	
	Choose ONE:		
CHEM 112	Introductory Chemistry II	4.0	
CSCI 151	Intro to Prog. Data Science	4.0	

BACHELOR OF SCIENCE IN EDUCATION (PHYSICS)

SAMPLE PROGRAM (120 sh. minimum)

FIRST SEMESTER

UNIV 103	Inquiry Seminar	3.0
MATH 161	Calculus I	4.0
CHEM 111	Intro Chemistry I	4.0
ENGL 110	English Composition	3.0
WELL 175	Wellness	3.0
	TOTAL S.H.	17.0

SECOND SEMESTER

PHYS 231	Physics I w/Calculus	5.0
MATH 211	Calculus II	4.0
CHEM 112	Intro. Chemistry II	4.0
COMM 100	Fund. Of Speech	3.0
	TOTAL S.H.	16.0

THIRD SEMESTER

PHYS 232	Physics II w/Calculus	5.0
MATH 311	Calculus III	4.0
EDFN 211	Found. Mod. Educ.	3.0
EDFN 241	Psych. Found. Tchg.	3.0
	TOTAL S.H.	15.0

FOURTH SEMESTER

PHYS 233	Theory Wave/Particles	3.0
PHYS 266	Electronics	3.0
PHYS 334	Macro/Thermodynamics	3.0
MATH 365	Ord. Diff. Equations	3.0
____ ____	Hum./Soc. Science #1	3.0
____ ____	Elective	3.0
	TOTAL S.H.	18.0

FIFTH SEMESTER

PHYS 311	Mechanics I	3.0
*PHYS 317	Intro. Astronomy	3.0
PHYS 351	Intermediate Lab I	1.0
____ ____	Hum./Soc. Science #2	3.0
____ ____	Hum./Soc. Science #3	3.0
	TOTAL S.H.	13.0

SIXTH SEMESTER

PHYS 321	Electro Mag Fields I	3.0
PHYS 352	Intermediate Lab II	1.0
PHYS 498	Ind. Study/Research	1.0
____ ____	Hum./Soc. Science #4	3.0
____ ____	Hum./Soc. Science #5	3.0
____ ____	Hum./Soc. Science #6	3.0
ENGL 312	Technical Writing	3.0
	TOTAL S.H.	17.0

SEVENTH SEMESTER

PHYS 492	Research/Seminar	2.0
EDSE 321	Prob. Sec. Education	3.0
EDFN 330	Instruct Tech. Design	3.0
EDSE 435	Teaching Science	3.0
***EDSE 340	Diverse Classrooms	3.0
SPED 346	Stds. W/ Disab. in Incl Sets	3.0
	TOTAL S.H.	17.0

EIGHTH SEMESTER

EDSE 471	Differentiating Inst.	3.0
EDXX 461	Student Teaching	9.0
	TOTAL S.H.	12.0

COMMENTS, NOTES OR RECOMMENDATIONS

COMMENTS, NOTES OR RECOMMENDATIONS

* ESCI 241 may be substituted for PHYS 317

** The Pennsylvania Department of Education requires 6 credits of English; 3 in writing and 3 in literature. Therefore, each BSE student MUST take 3 credits of writing (ENGL 110) AND 3 credits of literature in the English Dept. A “G1” English literature course fulfills this requirement. This is a prerequisite requirement and MUST be completed before you can enter the Professional Block and Student Teaching.

*** Counts as general education course in the “Connections & Exploration” requirements.

1. In practice, expect to select the 4 required writing (W) courses and the required diversity (D) and perspective (P)courses from the 6 Humanities/Social Science courses.

2. The open elective is used to satisfy the “Connections & Exploration” general education requirements, #1 and #4 on the green sheet.

MILLERSVILLE UNIVERSITY

Student Name:_____ Student I.D. #:_____

Curriculum Record Form for an Academic Minor in Physics

Minor: Physics
Department: Physics

Total credit hours required: 18-19 cr.

Regulations Governing Minor Course Work:

1. There shall be a minimum of 18.0 credit hours with a minimum Millersville QPA of 2.0.
2. Only one course which counts toward the major may be counted toward the minor.
3. Courses that count toward a minor are also eligible to be used to satisfy the current University-wide General Education requirements subject to normal distribution requirements.
4. At least two courses should be at the upper-division level (300-400).
5. No course needed for the minor may be taken Pass-Fail.
6. One-half or more of the work required for the minor must be completed at Millersville University.
7. No student may minor in his or her major.

REQUIRED PHYSICS COURSES (18-19 cr.)

Course No.	Short Title	C.H.	Grade
PHYS 231	Physics I with Calculus	5.0	
PHYS 232	Physics II with Calculus	5.0	
PHYS 233	Wave-Particle Theory	3.0	
PHYS 334	Macroscopic Physics	3.0	

Choose one of the following:

Course No.	Short Title	C.H.	Grade
PHYS 311	Mechanics I	3.0	
PHYS 317	Intro Astronomy/Astrophysics	3.0	
PHYS 321	Electromagnetic Fields I	3.0	
PHYS 331	Fundamentals of Optics	2.0	
PHYS 395	Mathematical Physics	3.0	
PHYS 431	Solid State Physics	3.0	
PHYS 435	Statistical Mechanics	3.0	
PHYS 471	Quantum Mechanics	3.0	

Completion of the Calculus sequence (listed below) is a **prerequisite** for the minor in Physics. These courses are not included in the minor credit total.

Course No.	Short Title	C.H.	Grade
MATH 161	Calculus I		
MATH 211	Calculus II		
MATH 311	Calculus III		

Note to the student: *This form is provided as a guide. It is your responsibility to consult regularly with your advisor to be aware of changes and curriculum details which are not incorporated on this form.*