

Western Kentucky University
Department of Physics and Astronomy
Undergraduate Student Planning and Advising Manual



Department of Physics and Astronomy
Western Kentucky University
1906 College Heights Blvd. #11077
Bowling Green, KY 42101-1077

Tel: (270)745-4357

Fax: (270)745-2014

E-Mail: Physics.Astronomy@wku.edu

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1 Introduction

Welcome to the Department of Physics and Astronomy at Western Kentucky University! This document is provided as a reference to plan your academic program as majors and minors in our department. Keep in mind that course offerings within our programs and in other departments can change from year-to-year, and thus **it's imperative that you frequently meet with an academic advisor to discuss your academic plans**. Please refer to the Undergraduate Course Catalog (provided by the Registrar, and available on the university website, <http://www.wku.edu>) for the most up-to-date course descriptions, requirements, and policies pertinent to both the Department of Physics and Astronomy and to Western Kentucky University. Please direct any questions, comments, or suggestions on this manual to the departmental office.

2 Departmental Information

The Department of Physics and Astronomy is primarily located on the second floor of the Kelly Thompson Complex for Science, Center Wing, where we maintain the majority of our classrooms and faculty offices. We have approximately 50 to 60 enrolled students progressing toward a Bachelors of Science in Physics. Our mission is to prepare these students for advanced careers, providing each with an essential foundation for a variety of professional goals. Our graduates go on to become physicists in academic, government, and industrial laboratories, and teachers in secondary science education and vocational training. Our curriculum also prepares students for advanced-degree studies, in scientific graduate programs and in post-baccalaureate professional and engineering programs.

We maintain forefront facilities and equipment in support of our curriculum. From introductory University Physics to Atomic Physics and Optics, our laboratories are well equipped with modern apparatuses and data acquisition interfaces using software that is standard in the physics community. The Applied Physics Institute features truly unique facilities such as the large-chamber scanning electron microscope and the CyberDefence Laboratory, providing a multidisciplinary center for upper-level studies in nuclear physics, material science, medical physics, and homeland security. The Hardin Planetarium (adjacent to the building), and the rooftop observatory (featuring a 12-inch refracting telescope), support introductory astronomy laboratories and public outreach opportunities for school groups and the general public. Students specializing in Astrophysics have access to two remotely operated astronomical observatories: the remote controlled Bell Observatory 24-inch telescope in rural Bowling Green, Kentucky; and the fully autonomous RCT 50-inch telescope located at Kitt Peak, Arizona.

Early science education is of critical importance to preparing future researchers and engineers, and to maintaining a science-literate society as a whole. In collaboration with the SKyTeach program, we offer degree programs to become certified in secondary school Physics Education, and in Science and Math education at the middle school level.

The diversity of our faculty is a major strength of our program, allowing students to benefit from a breadth of specializations. Our students are encouraged to participate in research opportunities with faculty members, generally starting in the second year of major course work. Student-researchers can be supported by available scholarships, work-study assistantships, or can earn independent study course credit.

3 Tenured and Tenure-Track Faculty

The faculty in the WKU Department of Physics and Astronomy are dedicated to serving the student majors and minors within the department. Feel free to contact any faculty member listed below if you have any questions about your academic program or other areas of the department.

Table 1: Faculty Information

| Name Position | Office (*) | Phone Area Code (270) | Electronic Mail |
|---|-------------------|------------------------------------|--|
| Dr. Keith Andrew Professor, Department Head, Director of the Cyber Defense Laboratory | TCCW 247 | 745-4357 | Keith.Andrew@wku.edu |
| Dr. Alexander Barzilov Associate Professor, Director of the Applied Physics Institute | TCCW 214 | 745-5484 | Alexander.Barzilov@wku.edu |
| Dr. Scott Bonham Associate Professor, Chair of SKyTeach Program | TCCW 217 | 745-6196 | Scott.Bonham@wku.edu |
| Dr. Michael Carini Professor, Director of the Bell Observatory | TCCW 229 | 745-6198 | Mike.Carini@wku.edu |
| Dr. Vladimir Dobrokhoto Assistant Professor | TCCW 221 | 745-6201 | Vladimir.Dorokhotov@wku.edu |
| Dr. Richard Gelderman Professor, Director of the RCT Observatory | TCCW 230 | 745-6203 | Richard.Gelderman@wku.edu |
| Dr. Steven Gibson Assistant Professor | TCCW 231 | 745-3019 | Steven.Gibson@wku.edu |
| Dr. Doug Harper Madole Family – Ogden Professor | TCCW 226 | 745-6194 | Doug.Harper@wku.edu |
| Dr. Edward Kintzel Assistant Professor | TCCW 254 | 745-6200 | Edward.Kintzel@wku.edu |
| Dr. Charles H. McGruder, III William McCormack Professor | TCCW 220 | 745-5277 | Charles.McGruder@wku.edu |
| Dr. Ivan Novikov Assistant Professor | TCCW 246 | 745-4357 | Ivan.Novikov@wku.edu |
| Dr. Roger L. Scott Professor, Director of the Hardin Planetarium | TCCW 224 | 745-3817 | Roger.Scott@wku.edu |
| Dr. Louis-Gregory Strolger Associate Professor | TCCW 225 | 745-6204 | Louis.Strolger@wku.edu |
| Dr. B. Wieb van der Meer Professor | TCCW 227 | 745-6205 | Wieb.Vandermeer@wku.edu |
| Dr. Phillip Womble Professor | TCCW 232 | 745-4052 781-3859 | Phillip.Womble@wku.edu |

* TCCW = Thompson Complex, Central Wing

4 Departmental Advisors

Each student at WKU is assigned an academic advisor in his or her major area of study. All students who do not have an approved degree program on file with the university must meet with their advisor each semester and gain approval of their proposed course schedule prior to registration. You should find your advisor to be a resource person who is happy to help you to plan and make wise choices regarding your academic program. You should also feel free to go to your academic advisor with any problem or issue that you may be facing. He or she will attempt to help you or refer you to appropriate personnel on campus who may be better suited to help with your problem.

The relationship between you and your advisor is a very important one. If for any reason you desire to change your advisor you should feel free to do so without any worry of upsetting your present advisor. Simply ask in the departmental office be assigned a new advisor or go to the faculty member of your choice to request that he/she become your new advisor.

Current department advisors are listed below. All advise for the Physics Graduate Preparation track in Physics (reference code 754) and Minor in Physics (reference code 435), but also advise in specific programs of study shown in the table below.

Table 2: Physics and Astronomy Special Programs of Study

| Special Program of Study (ref. code) | Advisors |
|--|--|
| Pre-Engineering (815) Applied Science/Engineering Dual-Degree EE/Physics Double Major (Proposed) | Keith Andrew, Doug Harper, Philip Womble |
| Secondary Physics Teaching Middle School Science Education (734) | Scott Bonham, Richard Gelderman |
| Astrophysics Astronomy Minor (318) | Michael Carini, Richard Gelderman, Louis-Gregory Strolger |
| Applied Nuclear Physics | Alex Barzilov, Ivan Novikov, Philip Womble |
| Biophysics Minor (329) | Ivan Novikov, Wieb van de Meer |

5 Major Programs of Study in the Department of Physics and Astronomy

All of the programs described in this manual are designed to provide a sound knowledge of physical principles. The programs are also flexible to the extent that the student can select related courses in biology, chemistry, geology or astronomy to prepare for a career in interdisciplinary areas such as biophysics, geophysics, environmental science or chemical physics. When planning your program of study, you should be aware of the University academic requirements and regulations contained in the University Catalog in the chapter, "Academic Information." Specific attention should be given to the sub-

sections in the chapter entitled (a) Academic Programs, (b) General Requirements, and (c) Academic Requirements and Regulations.

5.1 General Education Requirements

All students following a four-year undergraduate degree program at WKU must fulfill general education requirements as described in the University Catalog, and summarized in the table below.

Table 3: Requirements for General Education

| | | |
|---|--|-----------------------------|
| A. | Organization and Communication of Ideas I. ENG 100 - Freshman English I. ENG 300 - Junior English II. Second semester of a foreign language III. SCOM 145 or 161 - Public Speaking | 12 Hours |
| B. | Humanities (At least three fields must be represented) I. ENG 200 – Literature II. Elective _____ II. Elective _____ | 9 Hours |
| C. | Social and Behavioral Sciences (At least three fields must be represented) HIST 119 or 120 - Western Civilization Elective _____ Elective _____ | 9 Hours |
| D. | Natural Sciences & Mathematics I. PHYS 255/256 - University Physics I Lecture/Lab I. CHEM 120/121 - College Chemistry I Lecture/Lab II. MATH 136 - Calculus I | 9 Hours |
| E. | World Cultures and American Diversity Elective _____ | 3 Hours |
| F. | Health and Wellness Two activity courses (PE 100, 101, 102, 103 or 104) Or HE 100 - Personal Health (Required for Teacher Certification) | 2 Hours |
| Total General Education Requirements | | 44 Hours¹ |

See the University Catalog or a Course Bulletin for the current semester for a complete list of courses that satisfy each of the above general education categories.

¹ For Physics majors, PHYS 255/256, CHEM 120/121, and MATH 136 satisfy all Category D general education requirements, reducing the non-major additional requirements to 35 credit hours.

5.2 Major in Physics (Reference Code 754)

The major in physics (reference code 754) requires a minimum of 61 semester hours of physics courses and leads to a Bachelor of Science degree. A minor or second major in a complementary program is required. The required mathematics support courses for the Physics major (see below) constitute a minor in Mathematics (reference code 417).

Table 4: Basic Physics Requirements

| Area | Course | Description | Hours | |
|---|--|--|-------------|------------|
| Physics Core Courses | PHYS 180/181 | Introductory Modern Physics and Laboratory | 4.0 | |
| | PHYS 255/256 | University Physics I and Laboratory | 5.0 | |
| | PHYS 265/266 | University Physics II and Laboratory | 5.0 | |
| | PHYS 301 | Electrical Measurements Laboratory | 1.0 | |
| | PHYS 302 | Atomic Physics Laboratory | 1.0 | |
| | PHYS 321 | Modern Physics II | 3.0 | |
| | PHYS 350 | Classical Mechanics I | 3.0 | |
| | PHYS 398 | Junior Seminar | 0.5 | |
| | PHYS 440 | Electricity and Magnetism | 3.0 | |
| | PHYS 498 | Senior Seminar | 0.5 | |
| Total Required Physics Core Courses | | | 26.0 | |
| Physics Electives and Support Courses | PHYS ____ PHYS ____ PHYS ____ | Upper division physics electives chosen from the courses listed for departmental majors and minors, excluding PHYS 389, 399 and 489. No more than 3 hours of PHYS 475 may be counted toward the 9-hour minimum requirement for these restricted electives. | 9.0 | |
| | Total Required Physics Elective Courses | | | 9.0 |
| | MATH 136 | Calculus and Analytical Geometry I | 4.0 | |
| | MATH 137 | Calculus and Analytical Geometry II | 4.0 | |
| | MATH 237 | Multivariable Calculus | 4.0 | |
| | MATH 307 | Introduction to Linear Algebra | 3.0 | |
| | MATH 331 | Differential Equations | 3.0 | |
| | CS | Computer Science Course (CS 180 suggested) | 3.0 | |
| | CHEM 120/121 | College Chemistry I and Laboratory | 5.0 | |
| Total Required Physics Support Courses | | | 26.0 | |
| Minimum Required for Physics Certificate | | | 61.0 | |

Students preparing for graduate study or are pursuing a terminal bachelors of science advised to take additional departmental courses and/or additional sequences in other departments in support of their goals. The department has prepared several career-oriented options, which detail relevant departmental electives and additional or approved substitute support courses. The basic option, the Physics Graduate Preparation track, is designed for those students who wish to pursue careers in physics or astronomy and are preparing for graduate study. Student must work closely with the departmental advisor from the beginning to plan a program of study that meets departmental and University requirements and that maximize preparation to meet career goals.

5.2.1 Placement Exams

Prior to your first semester at WKU, and usually prior to or during your Academic Transitions Program orientation, you will be **required** to take at least three placement exams, the results of which will have lasting effect on your progress to your degree in physics. Some details and impacts of these exams are detailed below. There are additional placement exams that may be taken if you have had sufficient High School experience (e.g., in foreign language) to place out of preparatory courses. Speak with the Academic Transition Program coordinators for additional details on these placement exams, or see their website, <http://www.wku.edu/orientation>.

1. *The Math Placement Exam*— This exam is broken into two parts, the Online Mathematics Placement Exam (MPE), which all incoming students are required to take, and the Mathematics Placement Trigonometry Exam (MPTE), which is required for students majoring in most science programs, *including physics*. Both exams can be taken on-line, either prior to or during ATP, once you have already obtained a WKU ID#. **Please see the important note below.**
2. *The Chemistry Placement Exam*— Students majoring in most science programs (including physics) are required to take the Chemistry Placement Exam (CPE). This exam must be taken in person, either before or during ATP. The CPE is 55-minute exam on basic algebra, basic chemistry, and advanced chemistry. The results of the CPE will determine if you are eligible to take CHEM 120/121 (required for the physics degree), CHEM 116 prior to CHEM 120/121, or no chemistry at all until MATH 116 (College Algebra) is taken. Generally there is no preparation necessary for this exam, although some moderate math review can help to improve placement. There is a \$13 service fee that must be paid on-line prior to the exam.
3. *Computer Science Placement Exam*—The Computer Science Placement Exam (CSPE) is an optional exam offered to students interested in taking CS 180 (Computer Science I; recommended). This exam is taken in person, and must be obtained from the Math and Computer Science Department. The results of the CSPE determine if you are eligible to take CS 180, or must take CS 170 prior to CS 180.

An important note on the Math Placement Exam: It is essential that students have sufficient math preparation before beginning the major course work in the physics curriculum. Students are frequently surprised to learn that the MPE is moderately challenging and long (55 minutes for the MPE + 30 minutes for the MPTE). Moreover the exam is essentially only taken once, making the results lasting. Poor performance can significantly delay progress toward your degree. Some moderate preparation for the exam could be the difference between entering the University Physics sequence in your first year, or having to wait until your second year. ***We strongly advise students to prepare for the Math Placement Exam prior to taking this test, either on-line or during your ATP orientation. This will insure a placement commensurate with the courses you have taken prior to enrollment.***

The following sections detail the course work recommended to complete the basic and special programs of study. The program elective options can be changed to meet the particular interests of each student.

5.2.2 Physics Graduate Preparation Option

This option is designed to prepare students for graduate study in physics. Elective courses are chosen in the basic physics areas of mechanics, electricity and magnetism, statistical mechanics and quantum mechanics. Interested students may choose to take additional courses in specialty areas such as optics, solid-state physics, and nuclear physics if desired.

Table 5: Physics Graduate Preparation Required and Recommended Courses

| Area | Description | | | Hours ² |
|--|---|------------------------------|------|--------------------|
| Gen. Ed | Minimum additional General Education requirements | | | 35.0 |
| Physics Core | Required Physics core courses | | | 26.0 |
| Recommended Physics Elective Courses | PHYS 330 | Thermodynamics | 3.0 | |
| | PHYS 450 | Classical Mechanics II | 3.0 | |
| | PHYS 480 | Quantum Mechanics | 3.0 | |
| | Total Recommended Physics Elective Courses | | | 9.0 |
| Physics Support | Required Physics Support Courses | | | 26.0 |
| Recommended Physics Specialty Courses | PHYS 316 or 318 | Physics Computing | 3.0 | |
| | PHYS 441/404 | Optics + Laboratory | 4.0 | |
| | PHYS 445 | Electricity and Magnetism II | 3.0 | |
| | PHYS 460/406 | Solid State Physics + Lab | 4.0 | |
| | PHYS 470/407 | Nuclear Physics + Lab | 4.0 | |
| Recommended Additional Specialty Courses | | | 18.0 | |
| Second Major | Mathematics - Reference Code 728 | | | 19.0 |
| Total Curriculum Hours | | | | 133.0 |

We have prepared some suggested programs of studies (shown in the following tables) as examples to help you plan your course to graduation. Your actual four-year plan may vary based on your career interests and your pre-matriculation math preparedness (see important note on math placement in the section 5.2.1).

² The total curriculum hours for each student depend on the individual's preparation when entering the program of study.

Table 6: Physics Graduate Preparation - Suggested Program of Study I

Major in Physics & Astronomy + Major in Mathematics & Computer Science

| 1st Fall Semester | | | | 1st Spring Semester | | | | | |
|-------------------------------------|------------|--|--------------------|---------------------------------------|------------|-------------------------------------|-----|--------------------|-------------|
| MATH | 136 | Calculus and Analytical Geometry I | 4.0 | MATH | 137 | Calculus and Analytical Geometry II | 4.0 | | |
| ENG | 100 | Freshman English | 3.0 | PHYS | 255 | University Physics I | 4.0 | | |
| PHYS | 180 | Introductory Modern Physics | 3.0 | PHYS | 256 | University Physics I Laboratory | 1.0 | | |
| PHYS | 181 | Introductory Modern Physics Laboratory | 1.0 | CHEM | 120 | College Chemistry I | 4.0 | | |
| | | General Education B-II Elective | 3.0 | CHEM | 121 | College Chemistry I Laboratory | 1.0 | | |
| COMM | 145 or 161 | Public Speaking | 3.0 | HIST | 119 or 120 | Western Civilization | 3.0 | | |
| | | | Total Hours | 17.0 | | | | Total Hours | 17.0 |
| 2nd Fall Semester | | | | 2nd Spring Semester | | | | | |
| MATH | 310 | Discrete Math | 3.0 | PHYS | 321 | Modern Physics II | 3.0 | | |
| MATH | 307 | Introduction to Linear Algebra | 3.0 | PHYS | 301 | Electrical Measurements Laboratory | 1.0 | | |
| PHYS | 265 | University Physics II | 4.0 | MATH | 237 | Multivariable Calculus | 4.0 | | |
| PHYS | 266 | University Physics II Laboratory | 1.0 | | | General Education E Elective | 3.0 | | |
| | 101 | Gen. Ed. A-II Foreign Language Prep. | 3.0 | | 102 | Foreign Language (Gen. Ed. A-II) | 3.0 | | |
| ENG | 200 | Literature | 3.0 | CS | 180 | Computer Science I | 3.0 | | |
| | | | Total Hours | 17.0 | | | | Total Hours | 17.0 |
| 3rd Fall Semester | | | | 3rd Spring Semester | | | | | |
| MATH | 382 | Probability and Statistics I | 3.0 | PHYS | 440 | Electricity and Magnetism I | 3.0 | | |
| PHYS | 350 | Classical Mechanics I | 3.0 | PHYS | 316 or 318 | Physics Computing | 3.0 | | |
| PHYS | 330 | Thermodynamics | 3.0 | PHYS | 470 | Nuclear Physics | 3.0 | | |
| PHYS | 302 | Atomic Physics Laboratory | 1.0 | PHYS | 407 | Nuclear Physics Laboratory | 1.0 | | |
| MATH | 331 | Differential Equations | 3.0 | PHYS | 398 | Junior Seminar | 0.5 | | |
| | | General Education F | 2.0 | MATH | 435 | Partial Differential Equations | 3.0 | | |
| | | General Education C Elective | 3.0 | ENG | 300 | Junior English | 3.0 | | |
| | | | Total Hours | 18.0 | | | | Total Hours | 16.5 |
| 4th Fall Semester | | | | 4th Spring Semester | | | | | |
| PHYS | 460 | Solid State Physics | 3.0 | PHYS | 450 | Classical Mechanics II | 3.0 | | |
| PHYS | 406 | Solid State Physics Lab | 1.0 | PHYS | 445 | Electricity and Magnetism II | 3.0 | | |
| PHYS | 441 | Optics | 3.0 | MATH | 429 | Probability and Statistics II | 3.0 | | |
| PHYS | 404 | Optics Laboratory | 1.0 | MATH | 450 | Complex Variables | 3.0 | | |
| PHYS | 480 | Quantum Mechanics | 3.0 | MATH | 498 | Senior Seminar | 1.0 | | |
| PHYS | 498 | Senior Seminar | 0.5 | | | General Education (B II) | 3.0 | | |
| MATH | 317 | Introduction to Algebraic Systems | 3.0 | | | | | | |
| | | General Education C Elective | 3.0 | | | | | | |
| | | | Total Hours | 17.5 | | | | Total Hours | 16.0 |

Table 7: Physics Graduate Preparation - Suggested Program of Study II

Major in Physics & Astronomy + Minor in Mathematics & Computer Science

| 1st Fall Semester | | | | 1st Spring Semester | | | | | |
|-------------------------------------|------------|--|--------------------|---------------------------------------|---------------------|---|-----|--------------------|-------------|
| MATH | 117 | Trigonometry | 3.0 | MATH | 136 | Calculus and Analytical Geometry I | 4.0 | | |
| ENG | 100 | Freshman English | 3.0 | PHYS | 100, 103, or 130 | Energy; Light, Color, and Vision; or Acoustics of Music and Speech | 3.0 | | |
| PHYS | 180 | Introductory Modern Physics | 3.0 | | 101 | Gen. Ed. A-II Foreign Language Prep. | 3.0 | | |
| PHYS | 181 | Introductory Modern Physics Laboratory | 1.0 | ENG | 200 | Literature | 3.0 | | |
| | | General Education B-II Elective | 3.0 | HIST | 119 or 120 | Western Civilization | 3.0 | | |
| COMM | 145 or 161 | Public Speaking | 3.0 | | | | | | |
| | | | Total Hours | 16.0 | | | | Total Hours | 16.0 |
| 2nd Fall Semester | | | | 2nd Spring Semester | | | | | |
| MATH | 137 | Calculus and Analytical Geometry II | 4.0 | MATH | 237 | Multivariable Calculus | 4.0 | | |
| PHYS | 255 | University Physics I | 4.0 | PHYS | 265 | University Physics II | 4.0 | | |
| PHYS | 256 | University Physics I Laboratory | 1.0 | PHYS | 266 | University Physics II Laboratory | 1.0 | | |
| CHEM | 120 | College Chemistry I | 4.0 | | | General Education E Elective | 3.0 | | |
| CHEM | 121 | College Chemistry I Laboratory | 1.0 | CS | 170 or 180 | Introduction to Programming, or Computer Science I | 3.0 | | |
| | 102 | Foreign Language (Gen. Ed. A-II) | 3.0 | | | | | | |
| | | | Total Hours | 17.0 | | | | Total Hours | 15.0 |
| 3rd Fall Semester | | | | 3rd Spring Semester | | | | | |
| MATH | 331 | Differential Equations | 3.0 | PHYS | 321 | Modern Physics II | 3.0 | | |
| MATH | 307 | Introduction to Linear Algebra | 3.0 | PHYS | 301 | Electrical Measurements Laboratory | 1.0 | | |
| PHYS | 350 | Classical Mechanics I | 3.0 | PHYS | 316 or 318 | Physics Computing | 3.0 | | |
| PHYS | 441 | Optics | 3.0 | | | General Education C Elective | 3.0 | | |
| PHYS | 404 | Optics Laboratory | 1.0 | PHYS | 398 | Junior Seminar | 0.5 | | |
| | | General Education F | 2.0 | MATH | 435 | Partial Differential Equations | 3.0 | | |
| | | | | ENG | 300 | Junior English | 3.0 | | |
| | | | Total Hours | 15.0 | | | | Total Hours | 16.5 |
| 4th Fall Semester | | | | 4th Spring Semester | | | | | |
| PHYS | 330 | Thermodynamics | 3.0 | PHYS | 450 | Classical Mechanics II | 3.0 | | |
| PHYS | 302 | Atomic Physics Laboratory | 1.0 | PHYS | 440 | Electricity and Magnetism I | 3.0 | | |
| PHYS | 460 | Solid State Physics | 3.0 | PHYS | 470 | Nuclear Physics | 3.0 | | |
| PHYS | 406 | Solid State Laboratory | 1.0 | PHYS | 407 | Nuclear Physics Laboratory | 1.0 | | |
| PHYS | 480 | Quantum Mechanics | 3.0 | | | General Education C Elective | 3.0 | | |
| PHYS | 498 | Senior Seminar | 0.5 | | | General Education (B II) | 3.0 | | |
| MATH | 382 | Probability and Statistics I | 3.0 | | | | | | |
| | | | Total Hours | 14.5 | | | | Total Hours | 16.0 |

5.2.3 Applied Physics Option

The Applied Physics option is designed to prepare students for positions in high-tech industry and national laboratories, or to prepare for graduate programs specifically in applied physics or engineering. The program differs from the general Physics Graduate Preparation option in providing a more extensive instruction to modern methods and applications of physics in industry.

As part of the curriculum, students are involved in two summer internships in industry or at national laboratories covering a total of six months (typically split into two 3-month sessions). Placement is organized through the Department of Physics and Astronomy in cooperation with the student and student's faculty mentor.

Table 8: Applied Physics Required and Recommended Courses

| Area | Description | | | Hours |
|--------------------------------------|---|--|-----|-------|
| Gen. Ed | Minimum additional General Education requirements | | | 35.0 |
| Physics Core | Required Physics core courses | | | 26.0 |
| Recommended Physics Elective Courses | PHYS 330 | Thermodynamics | 3.0 | |
| | PHYS 450 | Classical Mechanics II | 3.0 | |
| | PHYS 480 | Quantum Mechanics | 3.0 | |
| | Total Recommended Physics Elective Courses | | | 9.0 |
| Physics Support | Required Physics Support Courses | | | 26.0 |
| Internships | Summer Internship I & II | | | 2.0 |
| Additional Physics Specialty Courses | PHYS 301 | Electrical Measurements Lab | 1.0 | |
| | PHYS 316 or 318 | Physics Computing | 3.0 | |
| | PHYS 340/303 | Circuit Theory + Electronics Lab | 4.0 | |
| | PHYS 441/404 | Optics + Laboratory | 4.0 | |
| | PHYS 460/406 or PHYS 470/407 | Solid State Physics + Lab or Nuclear Physics + Lab | 4.0 | |
| | PHYS 337 or PHYS 431 | Medical Imaging + Lab or Radiation Biophysics | 4.0 | |
| | Recommended Additional Specialty Courses | | | 20.0 |
| Second Major | Mathematics - Reference Code 728 | | | 19.0 |
| Total Curriculum Hours | | | | 137.0 |

Table 9: Applied Physics Preparation - Suggested Program of Study

| 1st Fall Semester | | | | 1st Spring Semester | | | | | |
|-------------------------------------|------------|--|--------------------|---------------------------------------|------------|---|-----|--------------------|-------------|
| MATH | 136 | Calculus and Analytical Geometry I | 4.0 | MATH | 137 | Calculus and Analytical Geometry II | 4.0 | | |
| ENG | 100 | Freshman English | 3.0 | PHYS | 255 | University Physics I | 4.0 | | |
| PHYS | 180 | Introductory Modern Physics | 3.0 | PHYS | 256 | University Physics I Laboratory | 1.0 | | |
| PHYS | 181 | Introductory Modern Physics Laboratory | 1.0 | CHEM | 120 | College Chemistry I | 4.0 | | |
| | | General Education B-II Elective | 3.0 | CHEM | 121 | College Chemistry I Laboratory | 1.0 | | |
| COMM | 145 or 161 | Public Speaking | 3.0 | HIST | 119 or 120 | Western Civilization | 3.0 | | |
| | | | Total Hours | 17.0 | | | | Total Hours | 17.0 |
| 2nd Fall Semester | | | | 2nd Spring Semester | | | | | |
| MATH | 310 | Discrete Math | 3.0 | PHYS | 321 | Modern Physics II | 3.0 | | |
| MATH | 307 | Introduction to Linear Algebra | 3.0 | PHYS | 301 | Electrical Measurements Laboratory | 1.0 | | |
| PHYS | 265 | University Physics II | 4.0 | MATH | 237 | Multivariable Calculus | 4.0 | | |
| PHYS | 266 | University Physics II Laboratory | 1.0 | | | General Education E Elective | 3.0 | | |
| | 101 | Gen. Ed. A-II Foreign Language Prep. | 3.0 | | | Foreign Language (Gen. Ed. A II) | 3.0 | | |
| ENG | 200 | Literature | 3.0 | CS | 240 | Computer Science I | 3.0 | | |
| | | | | CS | 244 | Computer Science I Laboratory | 1.0 | | |
| | | | Total Hours | 17.0 | | | | Total Hours | 18.0 |
| Summer Internship I | | | | | | | | 1.0 | |
| 3rd Fall Semester | | | | 3rd Spring Semester | | | | | |
| MATH | 382 | Probability and Statistics I | 3.0 | PHYS | 340 | Circuit Theory | 3.0 | | |
| PHYS | 350 | Classical Mechanics I | 3.0 | PHYS | 303 | Electronics Lab | 1.0 | | |
| PHYS | 330 | Thermodynamics | 3.0 | PHYS | 316 or 318 | Physics Computing | 3.0 | | |
| PHYS | 302 | Atomic Physics Laboratory | 1.0 | PHYS | 470 | Nuclear Physics | 3.0 | | |
| MATH | 331 | Differential Equations | 3.0 | PHYS | 407 | Nuclear Physics Laboratory | 1.0 | | |
| | | General Education F | 2.0 | PHYS | 398 | Junior Seminar | 0.5 | | |
| | | General Education C Elective | 3.0 | MATH | 435 | Partial Differential Equations | 3.0 | | |
| | | | | ENG | 300 | Junior English | 3.0 | | |
| | | | Total Hours | 18.0 | | | | Total Hours | 17.5 |
| Summer Internship II | | | | | | | | 1.0 | |
| 4th Fall Semester | | | | 4th Spring Semester | | | | | |
| PHYS | 460 or 470 | Solid State Physics or Nuclear Physics | 3.0 | PHYS | 440 | Electricity and Magnetism I | 3.0 | | |
| PHYS | 406 or 407 | Solid State or Nuclear Physics Lab | 1.0 | PHYS | 470 or 337 | Radiation Biophysics or Medical Imaging | 4.0 | | |
| PHYS | 441 | Optics | 3.0 | MATH | 429 | Probability and Statistics II | 3.0 | | |
| PHYS | 404 | Optics Laboratory | 1.0 | MATH | 450 | Complex Variables | 3.0 | | |
| PHYS | 480 | Quantum Mechanics | 3.0 | MATH | 498 | Senior Seminar | 1.0 | | |
| PHYS | 498 | Senior Seminar | 0.5 | | | General Education (B II) | 3.0 | | |
| MATH | 317 | Introduction to Algebraic Systems | 3.0 | | | | | | |
| | | General Education C Elective | 3.0 | | | | | | |
| | | | Total Hours | 17.5 | | | | Total Hours | 17.0 |

5.2.4 Astrophysics Option

This option is designed to prepare students for graduate study in astronomy or astrophysics. Physics Electives include General Astronomy (ASTR 214), Observational Astronomy (ASTR 314), and Astrophysics (ASTR 414).

Table 10: Astrophysics Required and Recommended Courses

| Area | Description | | | Hours |
|--------------------------------------|---|-------------------------|-----|-------|
| Gen. Ed | Minimum additional General Education requirements | | | 35.0 |
| Physics Core | Required Physics core courses | | | 26.0 |
| Recommended Physics Elective Courses | PHYS 330 | Thermodynamics | 3.0 | |
| | PHYS 450 | Classical Mechanics II | 3.0 | |
| | PHYS 480 | Quantum Mechanics | 3.0 | |
| | Total Recommended Physics Elective Courses | | | 9.0 |
| Physics Support | Required Physics Support Courses | | | 26.0 |
| Additional Physics Specialty Courses | ASTR214 | General Astronomy | 4.0 | |
| | ASTR314 | Observational Astronomy | 4.0 | |
| | ASTR414 | Astrophysics | 4.0 | |
| | PHYS 441/404 | Optics + Laboratory | 4.0 | |
| | Recommended Additional Specialty Courses | | | 16.0 |
| Second Major | Mathematics - Reference Code 728 | | | 19.0 |
| Total Curriculum Hours | | | | 131.0 |

5.2.5 Physics Teaching Option

The Physics Teaching option prepares for certification in high school physics education. Students will take part in the SKyTeach program; an initiative designed for math and science teachers. Majors in both Physics and Science/Math Education are required. Recommended electives for the physics major include Physics for Teachers (PHYS 410) and Optics (PHYS 441/404)

Table 11: Physics Teaching Required and Recommended Courses

| Area | Description | | | Hours |
|--------------------------------------|---|----------------------|-----|-------|
| Gen. Ed | Minimum additional General Education requirements | | | 35.0 |
| Physics Core | Required Physics core courses | | | 26.0 |
| Recommended Physics Elective Courses | PHYS 330 | Thermodynamics | 3.0 | |
| | PHYS 410 | Physics for Teachers | 3.0 | |
| | PHYS 441/404 | Optics + Laboratory | 3.0 | |
| | Total Recommended Physics Elective Courses | | | 9.0 |
| Physics Support | Required Physics Support Courses | | | 26.0 |
| Second Major | SMED - Reference Code 774 | | | 34.0 |
| Total Curriculum Hours | | | | 130.0 |

Table 12: Astrophysics - Suggested Program of Study

| 1st Fall Semester | | | | 1st Spring Semester | | | | | |
|-------------------------------------|------------|--|--------------------|---------------------------------------|------------|-------------------------------------|-----|--------------------|-------------|
| MATH | 136 | Calculus and Analytical Geometry I | 4.0 | MATH | 137 | Calculus and Analytical Geometry II | 4.0 | | |
| ENG | 100 | Freshman English | 3.0 | PHYS | 255 | University Physics I | 4.0 | | |
| PHYS | 180 | Introductory Modern Physics | 3.0 | PHYS | 256 | University Physics I Laboratory | 1.0 | | |
| PHYS | 181 | Introductory Modern Physics Laboratory | 1.0 | CHEM | 120 | College Chemistry I | 4.0 | | |
| | | General Education B-II Elective | 3.0 | CHEM | 121 | College Chemistry I Laboratory | 1.0 | | |
| COMM | 145 or 161 | Public Speaking | 3.0 | HIST | 119 or 120 | Western Civilization | 3.0 | | |
| | | | Total Hours | 17.0 | | | | Total Hours | 17.0 |
| 2nd Fall Semester | | | | 2nd Spring Semester | | | | | |
| MATH | 310 | Discrete Math | 3.0 | PHYS | 321 | Modern Physics II | 3.0 | | |
| MATH | 307 | Introduction to Linear Algebra | 3.0 | PHYS | 301 | Electrical Measurements Laboratory | 1.0 | | |
| PHYS | 265 | University Physics II | 4.0 | MATH | 237 | Multivariable Calculus | 4.0 | | |
| PHYS | 266 | University Physics II Laboratory | 1.0 | | | General Education E Elective | 3.0 | | |
| ASTR | 214 | General Astronomy | 4.0 | | | Foreign Language (Gen. Ed. A II) | 3.0 | | |
| | 101 | Gen. Ed. A-II Foreign Language Prep. | 3.0 | CS | 240 | Computer Science I | 3.0 | | |
| | | | | CS | 244 | Computer Science I Laboratory | 1.0 | | |
| | | | Total Hours | 18.0 | | | | Total Hours | 18.0 |
| 3rd Fall Semester | | | | 3rd Spring Semester | | | | | |
| MATH | 382 | Probability and Statistics I | 3.0 | PHYS | 440 | Electricity and Magnetism I | 3.0 | | |
| PHYS | 350 | Classical Mechanics I | 3.0 | ASTR | 314 | Observational Astronomy | 4.0 | | |
| PHYS | 330 | Thermodynamics | 3.0 | ENG | 200 | Literature | 3.0 | | |
| PHYS | 302 | Atomic Physics Laboratory | 1.0 | PHYS | 398 | Junior Seminar | 0.5 | | |
| MATH | 331 | Differential Equations | 3.0 | MATH | 435 | Partial Differential Equations | 3.0 | | |
| | | General Education F | 2.0 | | | General Education C Elective | 3.0 | | |
| | | | Total Hours | 15.0 | | | | Total Hours | 16.5 |
| 4th Fall Semester | | | | 4th Spring Semester | | | | | |
| ENG | 300 | Junior English | 3.0 | PHYS | 450 | Classical Mechanics II | 3.0 | | |
| PHYS | 441 | Optics | 3.0 | ASTR | 414 | Astrophysics | 4.0 | | |
| PHYS | 404 | Optics Laboratory | 1.0 | MATH | 429 | Probability and Statistics II | 3.0 | | |
| PHYS | 480 | Quantum Mechanics | 3.0 | MATH | 450 | Complex Variables | 3.0 | | |
| PHYS | 498 | Senior Seminar | 0.5 | MATH | 498 | Senior Seminar | 1.0 | | |
| MATH | 317 | Introduction to Algebraic Systems | 3.0 | | | General Education (B II) | 3.0 | | |
| | | General Education C Elective | 3.0 | | | | | | |
| | | | Total Hours | 16.5 | | | | Total Hours | 17.0 |

Table 13: Physics Teaching - Suggested Program of Study

| 1st Fall Semester | | | | 1st Spring Semester | | | | | |
|-------------------------------------|------------|--|--------------------|---------------------------------------|------------|--------------------------------------|-----|--------------------|-------------|
| MATH | 136 | Calculus and Analytical Geometry I | 4.0 | MATH | 137 | Calculus and Analytical Geometry II | 4.0 | | |
| ENG | 100 | Freshman English | 3.0 | PHYS | 255 | University Physics I | 4.0 | | |
| PHYS | 180 | Introductory Modern Physics | 3.0 | PHYS | 256 | University Physics I Laboratory | 1.0 | | |
| PHYS | 181 | Introductory Modern Physics Laboratory | 1.0 | CS | 230 | Introduction to Programming | 3.0 | | |
| SMED | 101 | Intro to Inquiry-based Teaching | 1.0 | SMED | 102 | Intro to Inquiry-based Lesson Design | 2.0 | | |
| COMM | 145 or 161 | Public Speaking | 3.0 | HIST | 119 or 120 | Western Civilization | 3.0 | | |
| | 101 | Gen. Ed. A-II Foreign Language Prep. | 3.0 | | | | | | |
| | | | Total Hours | 18.0 | | | | Total Hours | 17.0 |
| 2nd Fall Semester | | | | 2nd Spring Semester | | | | | |
| MATH | 237 | Multivariable Calculus | 3.0 | PHYS | 321 | Modern Physics II | 3.0 | | |
| PHYS | 265 | University Physics II | 4.0 | PHYS | 301 | Electrical Measurements Laboratory | 1.0 | | |
| PHYS | 266 | University Physics II Laboratory | 1.0 | MATH | 307 | Introduction to Linear Algebra | 3.0 | | |
| ENG | 200 | Literature | 4.0 | | | Foreign Language (Gen. Ed. A II) | 3.0 | | |
| | | General Education C Elective | 3.0 | CHEM | 120 | College Chemistry I | 4.0 | | |
| SMED | 210 | Knowing & Learning Math/Sci | 3.0 | CHEM | 121 | College Chemistry I Laboratory | 1.0 | | |
| | | | | SMED | 320 | Classroom Interactions | 3.0 | | |
| | | | Total Hours | 18.0 | | | | Total Hours | 18.0 |
| 3rd Fall Semester | | | | 3rd Spring Semester | | | | | |
| PHYS | 350 | Classical Mechanics I | 3.0 | PHYS | 440 | Electricity and Magnetism I | 3.0 | | |
| PHYS | 302 | Atomic Physics Laboratory | 1.0 | PHYS | 330 | Thermodynamics | 3.0 | | |
| MATH | 331 | Differential Equations | 3.0 | ENG | 300 | Junior English | 3.0 | | |
| | | General Education B-II Elective | 3.0 | PHYS | 398 | Junior Seminar | 0.5 | | |
| | | General Education F | 1.0 | | | General Education F | 1.0 | | |
| | | General Education C Elective | 3.0 | | | General Education E Elective | 3.0 | | |
| SMED | 360 | Research Methods | 3.0 | SMED | 340 | Perspectives on Math and Science | 3.0 | | |
| | | | Total Hours | 17.0 | | | | Total Hours | 16.5 |
| 4th Fall Semester | | | | 4th Spring Semester | | | | | |
| PHYS | 410 | Physics for Teachers | 3.0 | SMED | 489 | Student Teaching Seminar | 3.0 | | |
| PHYS | 441 | Optics | 3.0 | SEC | 490 | Student Teaching | 10 | | |
| PHYS | 404 | Optics Laboratory | 1.0 | | | | | | |
| SMED | 470 | Project Based Instruction | 3.0 | | | | | | |
| PHYS | 498 | Senior Seminar | 0.5 | | | | | | |
| EXED | 330 | Intro to Exceptional Ed: Diversity | 3.0 | | | | | | |
| | | General Education B-II Elective | 3.0 | | | | | | |
| | | | Total Hours | 16.5 | | | | Total Hours | 17.0 |

5.3 Middle School Science Major (Reference Code 734)

The middle school science education major (MSSE, reference number 734) is for students who plan to teach science in grades 5 through 9. The MSSE major also requires completion of the science and mathematics education (SMED) program (counts as the second major requirement for the Physics Degree). Upon successful completion of both majors, the student will earn a Bachelor of Science degree and will qualify for an institutional recommendation for a Kentucky Provisional Certificate for teaching in the middle grades (5-9) science field.

To earn the MSSE degree, students must earn a grade of “C” or better in each of the required core courses, each of the restricted electives, and in a mathematics course chosen from MATH 117, 118, or 136. Students must have an overall grade point average of at least 2.5 for all completed science courses. Students who complete this major will receive a 6 hour waiver of the university requirement that at least half the minimum hours in the major be at the 300- or 400- level. Students seeking academic advising with regard to preparation as a mathematics or science teacher should contact the SKyTeach office, Hardin Planetarium, (270) 745-3900, or refer to the SKyTeach website – <http://skyteach.wku.edu> for additional information.

Table 14: Middle School Science Education Requirements

| Area | Course | Description | Hours |
|--|--|---|--------------|
| MSSE Core Courses | ASTR 104 or ASTR 106 | Astronomy of the Solar System or Astronomy of Stellar Systems | 3.0 |
| | GEOL 111/113 | The Earth and Laboratory | 4.0 |
| | GEOL 112/114 | Earth History and Laboratory | 4.0 |
| | BIOL 120/121 | Cells, Metabolism, and Genetics & Lab. | 4.0 |
| | BIOL 122/123 | Evolution, Diversity, and Ecology & Lab. | 4.0 |
| | CHEM 105/106 or CHEM 120/121 | Fundamentals of Gen. Chemistry and Lab. or College Chemistry and Laboratory | 4.0 min |
| | PHYS 105 | Concepts of the Physical World | 3.0 |
| | PHYS 201 or PHYS 231/232 | College Physics or Intro to Biophysics & Lab. | 4.0 |
| | SMED 360 | Research Methods (Science & Math) | 3.0 |
| | Minimum Required Physics Core Courses | | |
| MSSE Electives | Minimum of 15 semester credit hours required, representing at least three of the five science disciplines. Asterisk indicates that another restricted elective is a prerequisite: ASTR 405; GEOL 308, 310, 311, 325, 380, 405; GEOG 427*, 471; BIOL 325, 326, 327, 334, 319/322, 348, 350*, 407, 411/412*, 430*; PHYS 410. | | 15.0 |
| Second Major | SMED – Reference Code 774 | | 31.0 |
| Gen Ed. | Minimum General Education Requirements | | 38.0 |
| Minimum Required for MSSE Certificate | | | 117.0 |

5.4 Pre-Engineering Major (Reference Code 815)

A two-year pre-engineering program is offered for students who wish to pursue an engineering degree in a specific branch of engineering at an accredited engineering school. By careful selection of the non-technical electives in consultation with their advisor, an additional two years will usually be sufficient for the students to complete the degree requirements at the engineering school of their choice. A formal agreement for a 2-2 program exists between Western and the University of Missouri at Rolla. Several dual-degree (3-2) programs which award a Bachelor of Science degree in physics from Western Kentucky University and a degree in engineering from participating engineering schools are also available. See section 0 Physics/Engineering Dual-Degree for details.

5.5 Dual-Degree Option (Physics/Applied Sciences/Engineering)

This is a 3/2 option, that requires three years of study at Western Kentucky University and two years at an engineering school, leading to two degrees, one in physics and astronomy at Western Kentucky University and one in engineering at the selected school. Western Kentucky University has cooperative agreements with a number of engineering schools. Under these agreements a student can pursue his/her studies at Western Kentucky University for three years, taking courses in general education, mathematics, chemistry, and physics as required for a major in physics. The student then transfers to one of the engineering schools for an additional two years of study in an engineering area of his/her choice. By transfer of credit from the engineering school to Western Kentucky University and upon completion of the graduation requirements at Western Kentucky University, the student receives a Bachelor of Science degree in physics from Western Kentucky University. At the end of the fifth year and upon completion of the graduation requirements at the school of engineering, the student receives a Bachelor of Science degree in engineering from the cooperating school.

5.6 Electrical Engineering/Physics Double Major (proposed)

The program allows for a double major in Electrical Engineering and Physics, and satisfies the following course equivalencies:

| Physics | EE |
|----------------|-----------|
| PHYS 301 | EE 220 |
| PHYS 330 | ME 365 |
| PHYS 340 | EE 210 |
| PHYS 440 | EE 473 |
| PHYS 441/404 | EE 479 |
| PHYS 498 | EE 405 |

Table 15: EE/Physics - Suggested Program of Study

| 1st Fall Semester | | | | 1st Spring Semester | | | | | |
|-------------------------------------|------------|--|--------------------|---------------------------------------|------------|--|-----|--------------------|-------------|
| MATH | 136 | Calculus and Analytical Geometry I | 4.0 | MATH | 137 | Calculus and Analytical Geometry II | 4.0 | | |
| ENG | 100 | Freshman English | 3.0 | PHYS | 255 | University Physics I | 4.0 | | |
| PHYS | 180 | Introductory Modern Physics | 3.0 | PHYS | 256 | University Physics I Laboratory | 1.0 | | |
| PHYS | 181 | Introductory Modern Physics Laboratory | 1.0 | EE | 180 | Digital Circuits | 4.0 | | |
| EE | 175 | University Experience—EE | 2.0 | | | General Education F | 1.0 | | |
| COMM | 145 or 161 | Public Speaking | 3.0 | HIST | 119 or 120 | Western Civilization | 3.0 | | |
| | 101 | Gen. Ed. A-II Foreign Language Prep. | 3.0 | | | | | | |
| | | | Total Hours | 19.0 | | | | Total Hours | 17.0 |
| 2nd Fall Semester | | | | 2nd Spring Semester | | | | | |
| MATH | 331 | Differential Equations | 3.0 | PHYS | 321 | Modern Physics II | 3.0 | | |
| PHYS | 265 | University Physics II | 4.0 | MATH | 237 | Multivariate Calculus | 3.0 | | |
| PHYS | 266 | University Physics II Laboratory | 1.0 | EE | 211 | Circuits and Networks II | 3.5 | | |
| EE | 210 | Circuits and Networks I | 3.5 | EE | 220 | Introduction to Electronics | 4.0 | | |
| CS | 239 | Problem Solving w/ Comp. Techniques | 3.0 | EE | 200 | EE Design II | 1.0 | | |
| | | Foreign Language (Gen. Ed. A II) | 3.0 | ECON | 202 | Principles of Economics (Micro) | 3.0 | | |
| | | | | ENG | 200 | Literature | 3.0 | | |
| | | | Total Hours | 17.5 | | | | Total Hours | 20.5 |
| 3rd Fall Semester | | | | 3rd Spring Semester | | | | | |
| PHYS | 350 | Classical Mechanics I | 3.0 | PHYS | 302 | Atomic Physics Lab | 1.0 | | |
| PHYS | 330 | Thermodynamics | 3.0 | STAT | 301 | Intro. to Probability and Applied Statistics | 3.0 | | |
| MATH | 350 | Advanced Engineering Mathematics | 3.0 | ENG | 300 | Junior English | 3.0 | | |
| EE | 380 | Microprocessors | 4.0 | EE | 300 | EE Design III | 1.0 | | |
| | | General Education B-II Elective | 3.0 | | | General Education C Elective | 3.0 | | |
| | | General Education F | 1.0 | | | General Education E Elective | 3.0 | | |
| EE | 473 | Intro. to Electromagnetic Fields & Waves | 3.0 | EE | 420 | Signals and Linear Systems | 3.0 | | |
| | | | | EE | 479 | Fundamentals of Optoelectronics | 2.0 | | |
| | | | Total Hours | 20.0 | | | | Total Hours | 19.0 |
| 4th Fall Semester | | | | 4th Spring Semester | | | | | |
| EE | 400 | EE Design IV | 1.0 | EE | 401 | EE Design Project | 3.0 | | |
| EE | 460 | Continuous Control Systems | 4.0 | EE | | Senior Elective II | 3.0 | | |
| EE | 431 | Introduction to Power Systems | 3.0 | EE | 450 | Digital Signal Processing | 3.0 | | |
| EE | | Senior Elective I | 4.0 | EE | 451 | Digital Signal Processing Laboratory | 1.0 | | |
| EE | 405 | EE Senior Research Seminar | 1.0 | EE | 470 | Communications and Modulation | 3.0 | | |
| EM | 221 | UK Statistics | 3.0 | EE | 475 | Communication Systems Lab | 1.0 | | |
| | | Physics Elective | 3.0 | PHYS | 398 | Junior Seminar | 1.0 | | |
| | | | | | | General Education B-II Elective | 3.0 | | |
| | | | Total Hours | 19.0 | | | | Total Hours | 18.0 |

6 Minor Programs of Study in the Department of Physics and Astronomy

The Department of Physics and Astronomy offers several minor programs of study complementary with majors in science and mathematics. As with the major programs, each student should be aware of the University academic requirements and regulations contained in the University Catalog in the chapter, “Academic Information.” Specific attention should be given to the sub-sections in the chapter entitled (a) Academic Programs, (b) General Requirements, and (c) Academic Requirements and Regulations.

6.1 Minor in Physics (Reference Code 435)

The minor in physics (reference number 435) requires a minimum of 23 semester hours consisting of PHYS 250/251, 260/261, 270/271, 320 and a minimum of 6 semester hours selected from the lecture courses under the bulletin heading DEPARTMENTAL MAJORS AND MINORS.

Table 16: Physics Minor Requirements

| Area | Course | Description | Hours | |
|---|--|---|-------------|-------------|
| Physics Minor Core Courses | PHYS 180/181 | Introductory Modern Physics and Laboratory | 4.0 | |
| | PHYS 255/256 | University Physics I and Laboratory | 5.0 | |
| | PHYS 265/266 | University Physics II and Laboratory | 5.0 | |
| | PHYS 321 | Modern Physics II | 3.0 | |
| | Total Required Physics Core Courses | | | 17.0 |
| Minor Electives and Support Courses | PHYS ____ PHYS ____ | Upper division physics electives chosen from the courses listed for departmental majors and minors. | 6.0 | |
| | Total Required Physics Elective Courses | | | 6.0 |
| | MATH 136 | Calculus and Analytical Geometry I | 4.0 | |
| | MATH 137 | Calculus and Analytical Geometry II | 4.0 | |
| | Total Required Physics Support Courses | | | 26.0 |
| Minimum Required for Physics Minor | | | 31.0 | |

6.2 Minor in Biophysics (Reference Code 329)

The minor in biophysics (reference number 329) requires a minimum of 18 semester hours. This course sequence is intended to serve students in the life sciences, that is, students of biology, pre-medicine and pre-dental, agriculture, environmental health, psychology, science teaching, environmental engineering, pre-veterinary, pre-pharmacy and pre-optometry.

Table 17: Biophysics Minor Requirements

| Area | Course | Description | Hours |
|--|--|---|--------------|
| Biophysics Minor Core Courses | PHYS 231/232 | Intro to Physics and Biophysics I & Lab | 4.0 |
| | PHYS 332/233 | Intro to Physics and Biophysics II & Lab | 4.0 |
| | PHYS 335 or PHYS 337 or PHYS 431 | General Biophysics, or Medical Imaging, or Radiation Biophysics | 4.0 |
| | Total Required Physics Core Courses | | 12.0 |
| Biophysics Electives | PHYS ____ PHYS ____ | Upper division physics electives chosen from the courses listed for departmental majors and minors. Biology courses can be substituted with approval. | 6.0 |
| Minimum Required for Biophysics Minor | | | 18.0 |

6.3 *Minor in Astronomy (Reference Code 318)*

The minor in astronomy (reference number 318) requires a minimum of 20 semester hours and is designed to provide a background in astronomy and planetary science for students from a wide range of backgrounds. It provides a program of study for students majoring in science and math; to prepare them for employment in astronomy related fields in industry. Upon completion of the minor a student will have an understanding of the physical processes of galaxies, stars, and planetary systems; a familiarity with the tools and techniques of modern astronomical investigations; and an appreciation for the interdisciplinary nature of scientific research. The Astronomy minor has been designed with requirements flexible enough to allow students to specialize in any of the current areas of observational, theoretical, or computational astronomical research: including galactic, stellar, solar, and planetary astronomy. Students who intend to undertake graduate work in astronomy should complete a major in physics with a minor in mathematics. A minor in astronomy consists of 16 credit hours of required core courses and at least 4 credit hours from the list of restricted electives, as outlined in the table below.

Table 18: Requirements for Minor in Astronomy

| Requirement | Hours |
|--|--------------|
| Complete an introductory sequence of classical physics <ul style="list-style-type: none"> • PHYS 255/256 and PHYS 265/266 or • PHYS 201 and PHYS 202/208 or • PHYS 231/232 and PHYS 332/233 • (Physics majors must substitute GEOL 111/113 for PHYS 255/256) | 8.0 min |
| ASTR 214 – General Astronomy | 4.0 |
| ASTR 314 – Observational Astronomy | 4.0 |
| At least 4.0 hours from the following list of upper division courses chosen in consultation with the student’s advisor. <ul style="list-style-type: none"> • ASTR 414 – Astrophysics (4 hrs), • PHYS 316 – Computational Physics (3 hrs), • PHYS 441/404 – Optic (4 hrs), • PHYS 445 – Electromagnetism II (3 hrs), • PHYS 450 – Classical Mechanics II (3 hrs), • PHYS 465 or GEOL 465– Geophysics (3 hrs), • GEOL 325 – Intro to Rocks and Minerals (3 hrs), • GEOL 330 – Mineralogy (4 hrs), • GEOL 350 – Petrology (4 hrs), • GEOL 370 – Principles of Stratigraphy (4 hrs), • GEOL 420 – Geomorphology (4 hrs) | 4.0 |
| Minimum Required for Astronomy Minor | 20 |