

Program Modification

Program modifications must be submitted by October 15, 2015, and finalized by the end of that fall semester for catalog production.

Enter data in **YELLOWED** areas.

Date (Change date if modified and update the file name with the new date): 2012 2013 Catalog Copy **2016-2017; 03.30.16**

Program Area: **Applied Physics**

Semester /Year First affected: **Fall 2016**

Instructions: Please use this Program Modification form for changes to existing program requirements, units, outcomes, emphases or options, or for other programmatic concerns. For minor changes (faculty or address changes, additions of approved electives, minor editing for clarity, and other minor updates) use the Program Update form, available at the Curriculum website.

Paste the latest approved version of your entire program in the left AND right boxes below. Make your deletions in the LEFT column by using the strikeout feature in Word or underlining, **and highlight**. Insert new language or other changes to the program on the RIGHT and highlight in **YELLOW** for easy identification. If possible, please align the two columns so that changes appear side-by-side with the original text.

SUMMARY OF CHANGES

Updating and strengthening both emphases in the Major (e.g., adding an Optics course), and the Minor. The introductory lower-division sequence is expanded from two to three semesters, and PHYS 106 is removed. In the Physical Sciences emphasis, there are more lab courses, a choice of computer programming, and more electives on offer. The program learning outcomes are simplified, and use "measurable" language.

JUSTIFICATION

Overall, these changes increase the job marketability of our Majors (and Minors) and will help them to apply to graduate programs. 1. The **model transfer model** curriculum (see <http://www.C-ID.net>) requires a three semester introductory sequence at lower division, which both emphases will implement. 2. PHYS 106 Applied Physics and Society is redundant and has been removed to facilitate this. 3. Both emphases now benefit from having 3 upper division courses with labs (PHYS 310, 345 and 405). 4. Both emphases now include a core course in optics (PHYS 405), which is key to many modern developments in, for example, electro-optics: and Electronics (PHYS 310) and Digital Image Processing (PHYS 345) is added to the Physical Sciences emphasis to strengthen it. 5. A greater range of electives gives students more choice in following their individual interests. 6. Programming is a key skill used by physics graduates to go into employment in engineering or computer fields: the Physical Sciences emphasis incorporates a choice between two COMP courses. 7. The change in learning outcomes distills the many outcomes we previously had into a smaller list where every outcome occurs in almost every course. Also, the language suggested on the curriculum committee website has been applied to make the outcomes more "measurable".

The Minor in Applied Physics incorporates the sequence of three lower-division physics courses, and a wide choice of upper division electives (which were not available at its inception).

CURRENTLY APPROVED PROGRAM	PROPOSED PROGRAM
Applied Physics Programs Offered • Bachelor of Science in Applied Physics Emphasis in Technology Emphasis in Physical Sciences • Minor in Applied Physics Applied physics is the interface between science and technology, between the laboratory and industrial practice. It applies the concepts and models of physics to practical technological applications. Applied physics is essentially an interdisciplinary undertaking, interacting with mathematics, computer science, engineering, the life sciences, medicine and other disciplines. Applied physicists use their understanding and skills at the new scientific and technological frontiers that are developing rapidly at the interface between more traditional disciplines, e.g. biophysics, biomedical engineering, bioinformatics, materials science, and medical imaging. They have the flexibility to adapt to changing technological requirements and the ability to make meaningful contributions to modern, interdisciplinary investigations. Careers Graduates from the Bachelor of Science in Applied Physics will receive an excellent preparation for securing professional employment in industry or in the public sector. The Bachelor of Science in Applied Physics with an Emphasis in Technology is designed to produce graduates with strong problem-solving, technical, industrial and management skills. This will enable them to obtain professional employment on graduation in research and development in industry or in the public sector in, for example, electronics, semiconductors, medical technology and telecommunications. Through appropriate selection of electives, students can concentrate on selected areas within applied physics and pursue further study in graduate or professional schools, for example in Experimental Physics, Computer Engineering, Materials Science, Biomedical Engineering, or Medical Physics. The Bachelor of Science in Applied Physics with an Emphasis in Physical Sciences is designed to provide students with a broad foundation in applied physics as part of a	Applied Physics Programs Offered • Bachelor of Science in Applied Physics Emphasis in Technology Emphasis in Physical Sciences • Minor in Applied Physics • Minor in Astronomy Applied physics is the interface between science and technology, between the laboratory and industrial practice. It applies the concepts and models of physics to practical technological applications. Applied physics is essentially an interdisciplinary undertaking, interacting with mathematics, computer science, engineering, the life sciences, medicine and other disciplines. Applied physicists use their understanding and skills at the new scientific and technological frontiers that are developing rapidly at the interface between more traditional disciplines, e.g. biophysics, biomedical engineering, bioinformatics, materials science, and medical imaging. They have the flexibility to adapt to changing technological requirements and the ability to make meaningful contributions to modern, interdisciplinary investigations. Careers Graduates from the Bachelor of Science in Applied Physics will receive an excellent preparation for securing professional employment in industry or in the public sector. The Bachelor of Science in Applied Physics with an Emphasis in Technology is designed to produce graduates with strong problem-solving, technical, industrial and management skills. This will enable them to obtain professional employment on graduation in research and development in industry or in the public sector in, for example, electronics, semiconductors, medical technology and telecommunications. Through appropriate selection of electives, students can concentrate on selected areas within applied physics and pursue further study in graduate or professional schools, for example in Experimental Physics, Computer Engineering, Materials Science, Biomedical Engineering, or Medical Physics. The Bachelor of Science in Applied Physics with an Emphasis in Physical Sciences is

liberal education in the sciences. The program is particularly appropriate for students interested in such careers as teaching, public service, business, scientific equipment sales or science journalism. It can serve as the depth and breadth of study necessary for securing a single Subject credential in Science for teaching at the high school and middle school level.

The Applied Physics Minor provides non-majors with the background in science and technology that is needed to pursue a career or graduate study in an interdisciplinary field. Students majoring in Mathematics or Computer Science, in particular, should consider obtaining an Applied Physics minor because of the considerable overlap with these fields.

Program Learning Outcomes

Students graduating from the Applied Physics program will be able to:

- Explain the fundamental concepts of physics;
- Analyze and solve problems by applying information in a novel context;
- Formulate hypotheses and devise and perform experiments to test hypotheses as individuals and in a team;
- Apply current technology and scientific methodologies to analyze and solve problems in various scientific, professional and community settings;
- Use and critically evaluate current technical/scientific research literature, online information, and information related to scientific issues in the mass media;
- Communicate in written and oral forms key concepts in physics and general scientific issues with interested citizens and professionals;
- Work co-operatively as part of a research team; and
- Learn independently and maintain life-long learning in the sciences and technology.

Faculty

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designed to provide students with a broad foundation in applied physics as part of a liberal education in the sciences. The program is particularly appropriate for students interested in such careers as teaching, public service, business, scientific equipment sales or science journalism. It can serve as the depth and breadth of study necessary for securing a single Subject credential in Science for teaching at the high school and middle school level.

The Applied Physics Minor provides non-majors with the background in science and technology that is needed to pursue a career or graduate study in an interdisciplinary field. Students majoring in Mathematics or Computer Science, in particular, should consider obtaining an Applied Physics minor because of the considerable overlap with these fields.

Program Learning Outcomes

Students graduating from the Applied Physics program will be able to:

- 1. Demonstrate understanding of the general principles of physics
- 2. Demonstrate quantitative problem solving skills
- 3. Integrate the scientific method into problem-solving and experimentation
- 4. Demonstrate critical thinking in the context of physics
- 5. Demonstrate understanding of physics literature such as textbooks, laboratory manuals and publications geared toward undergraduates.

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Bachelor of Science Degree in Applied Physics with an Emphasis in Technology (120 units)

Summary of Units:

Lower Division Major Requirements	32
Upper Division Major Requirements	36
Upper Division Major Elective Requirements	40
Additional General Education and other	42
Graduation Requirements	
Total Units	120

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Bachelor of Science Degree in Applied Physics with an Emphasis in Technology (120 units)

Summary of Units:

Lower Division Major Requirements	33
Upper Division Major Requirements	40
Upper Division Major Elective Requirements	11
Additional General Education and other	36
Graduation Requirements	
Total Units	120

Lower Division Requirements - 32 units

MATH	150*	Calculus I	4
MATH	151	Calculus II	4
MATH	230*	Logic and Mathematical Reasoning	3
MATH	240	Linear Algebra	3
MATH	250	Calculus III	3
PHYS	106*	Applied Physics and Modern Society	3
PHYS	200*	General Physics I	4
PHYS	201*	General Physics II	4
COMP	150*	Object-Oriented Programming	4

Upper Division Requirements - 36 units

MATH	350	Differential Equations and Dynamical Systems	3
PHYS	301	Classical Mechanics	3
PHYS	304	Electromagnetism	4
PHYS	305	Thermal and Statistical Physics	3
PHYS	306	Modern Physics	3
PHYS	310	Electronics	4
PHYS	338*	Science and Conscience (ENGL)	3
PHYS	345*	Digital Image Processing (COMP/ MATH)	3
PHYS	400	Quantum Physics	3
PHYS	448*	Team-Based Research	3
PHYS	499	Senior Colloquium	1

and*Select 3 units from the following (any combination):*

PHYS	492	Internship	3
PHYS	494	Independent Research	1-3
PHYS	497	Directed Studies	1-3

Electives in the Major - 10-11 units*Select 10-11 units from the following:*

MATH	352	Probability and Statistics	3
MATH	448	Scientific Computing	3
MATH	450	Partial Differential Equations and Mathematical Physics	3
MATH	451	Complex Analysis	3

Lower Division Requirements - 33 units

COMP	150	Object Oriented Programming	4
MATH	150	Calculus I	4
MATH	151	Calculus II	4
MATH	230	Logic and Mathematical Reasoning	3
MATH	240	Linear Algebra	3
MATH	250	Calculus III	3
PHYS	200	General Physics I	4
PHYS	201	General Physics II	4
PHYS	202	General Physics III: Light, Relativity and Modern Physics	4

Upper Division Requirements - 40 units

MATH	350	Differential Equations and Dynamical Systems	3
PHYS	301	Classical Mechanics	3
PHYS	304	Electromagnetism	4
PHYS	305	Thermal and Statistical Physics	3
PHYS	306	Modern Physics	3
PHYS	310	Electronics	4
PHYS	338	Science and Conscience (ENGL)	3
PHYS	345	Digital Image Processing (COMP/ MATH)	3
PHYS	400	Quantum Physics	3
PHYS	405	Optics	4
PHYS	448	Team-Based Research	3
PHYS	499	Senior Colloquium	1

and*Select 3 units from the following (any combination):*

PHYS	492	Internship	3
PHYS	494	Independent Research	1-3
PHYS	497	Directed Studies	1-3

Electives in the Major - 11 units*Select 11 units from the following:*

MATH	352	Probability and Statistics	3
MATH	448	Scientific Computing	3
MATH	450	Partial Differential Equations and Mathematical Physics	3
MATH	451	Complex Analysis	3

PHYS	335*	Physics of Music (PAMU).....	3
PHYS	401‡	Quantum Mechanics	3
PHYS	406	Solid State Physics	3
PHYS	410‡	Introduction to Electro-Optics	4
PHYS	434*	Introduction to Biomedical Imaging (BIOL/HLTH)	4
PHYS	445*	Image Analysis and Pattern Recognition (COMP/MATH)	3
PHYS	464	Medical Instrumentation (BIOL)	4
PHYS	490	Topics in Physics	3
PHYS	492	Internship..... (if not taken as a required course)	3
PHYS	494†	Independent Research.....	1-3
PHYS	497†	Directed Studies	1-3

† Cannot exceed a total of 3 units, when added to units
taken within the upper division requirements

‡ Recommended for students proceeding to graduate school

~~* May be double-counted toward GE Requirements~~

Required Supporting and Other GE Courses

42 units

American Institutions Requirement.....	6
Other Courses in GE Categories A-E.....	27
Electives in Any Discipline	9

Bachelor of Science Degree in Applied Physics with an Emphasis in Physical Sciences - (120 units)

Summary of Units:

Lower Division Major Requirements	36
Upper Division Major Requirements	27
Upper Division Major Elective Requirements	15

PHYS	335	Physics of Music (PAMU).....	3
PHYS	401‡	Quantum Mechanics	3
PHYS	406‡	Solid State Physics.....	3
PHYS	410‡	Introduction to Electro-Optics	4
PHYS	434	Introduction to Biomedical Imaging (BIOL/HLTH)	4
PHYS	445	Image Analysis and Pattern Recognition (COMP/MATH).....	3
PHYS	464	Medical Instrumentation (BIOL)	4
PHYS	490	Topics in Physics	3
PHYS	492	Internship..... (if not taken as a required course)	3
PHYS	494†	Independent Research.....	1-3
PHYS	497†	Directed Studies	1-3

† Cannot exceed a total of 3 units, when added to units
taken within the upper division requirements

‡ Recommended for students proceeding to graduate school

Required Supporting and Other GE Courses **36 units**

American Institutions Requirement.....	6
Other Courses in GE Categories A-E.....	30

Bachelor of Science Degree in Applied Physics with an Emphasis in Physical Sciences - (120 units)

Summary of Units:

Lower Division Major Requirements	33-34
Upper Division Major Requirements	35
Upper Division Major Elective Requirements	9-10
Additional <u>General Education</u> and other	41-43

Additional [General Education](#) and other
[Graduation Requirements](#) **42**
Total Units 120

Lower Division Requirements - **36** units

CHEM	121	General Chemistry	4
MATH	150*	Calculus I	4
MATH	151	Calculus II	4
MATH	250	Calculus III	3
PHYS	106*	Applied Physics and Modern Society	3
PHYS	200*	General Physics I	4
PHYS	201*	General Physics II	4
PHYS	208*	Physics of Art and Visual Perception (ART)	3

and

Select either:

BIOL	200*	Principles of Organismal and Population Biology	4
or			
BIOL	201	Principles of Cell and Molecular Biology	4

and

COMP	102*	Web Development	3
or any higher COMP course			

Upper Division Requirements - **27** units

MATH	350	Differential Equations and Dynamical Systems	3
PHYS	304	Electromagnetism	4
PHYS	306	Modern Physics	3
PHYS	338*	Science and Conscience (ENGL)	3
PHYS	344*	Energy and Society (CHEM)	3
PHYS	434*	Introduction to Biomedical Imaging	
		(BIOL/HLTH)	4
PHYS	448	Team-Based Research	3

[Graduation Requirements](#)
Total Units 120

Lower Division Requirements - **33-34** units

CHEM	105	Introduction to Chemistry	3
MATH	150	Calculus I	4
MATH	151	Calculus II	4
MATH	250	Calculus III	3
PHYS	200	General Physics I	4
PHYS	201	General Physics II	4
PHYS	202	General Physics III: Light, Relativity and Modern Physics	4

and

Select either:

BIOL	200	Principles of Organismal and Population Biology	4
or			
BIOL	201	Principles of Cell and Molecular Biology	4

and

COMP	150	Object-Oriented Programming	4
or			
COMP	121	Introduction to Programming in C	3

Upper Division Requirements - **35** units

MATH	350	Differential Equations and Dynamical Systems	3
PHYS	304	Electromagnetism	4
PHYS	306	Modern Physics	3
PHYS	310	Electronics	4
PHYS	338	Science and Conscience (ENGL)	3
PHYS	345	Digital Image Processing (COMP/ MATH)	3
PHYS	405	Optics	4
PHYS	434	Introduction to Biomedical Imaging	
		(BIOL/HLTH)	4

PHYS 499	Senior Colloquium	1
and		
<i>Select 3 units taken from the following (any combination)</i>		
PHYS 492	Internship	3
	(Required for teachers)	
PHYS 494	Independent Research	1-3
PHYS 497	Directed Studies	1-3
Electives in the Major - 15 units		
<i>Chosen with advisor's approval</i>		
EDUC 330#	Teaching in Secondary Schools	3
MATH 240	Linear Algebra	3
MATH 352	Probability and Statistics	3
MATH 448	Scientific Computing	3
MATH 450	Partial Differential Equations and	
	Mathematical Physics	3
MATH 451	Complex Analysis	3
MCT 325	Entrepreneurial Management	3
PHYS 310	Electronics	4
PHYS 335*	Physics of Music (PAMU).....	3
PHYS 345*	Digital Image Processing	
	(COMP/MATH)	3
PHYS 436*	Physics of the Performing Arts (PA)	3
PHYS 445	Image Analysis and Pattern Recognition	
	(COMP/MATH)	3
PHYS 464	Medical Instrumentation (BIOL).....	4
PHYS 490	Topics in Physics	3
PHYS 492	Internship	3
	(if not taken as a required course)	
PHYS 494†	Independent Research	1-3
PHYS 497†	Directed Studies	1-3
† Cannot exceed a total of 3 units, when added to units taken within the upper division requirements		
# Recommended for Teachers		
(Courses with * are double counted toward GE credits)		
Required Supporting and Other GE Courses		
42 units		

PHYS 448	Team-Based Research	3
PHYS 499	Senior Colloquium	1
and		
<i>Select 3 units taken from the following (any combination)</i>		
PHYS 492	Internship	3
	(Required for teachers)	
PHYS 494	Independent Research	1-3
PHYS 497	Directed Studies	1-3
Electives in the Major - 9-10 units		
<i>Chosen with advisor's approval</i>		
EDUC 330#	Teaching in Secondary Schools	3
MATH 240	Linear Algebra	3
MATH 352	Probability and Statistics	3
MATH 448	Scientific Computing	3
MATH 450	Partial Differential Equations and	
	Mathematical Physics	3
MATH 451	Complex Analysis	3
PHYS 301	Classical Mechanics	3
PHYS 335	Physics of Music (PAMU).....	3
PHYS 344	Energy and Society (CHEM)	3
PHYS 400	Quantum Physics	3
PHYS 406	Solid State Physics.....	3
PHYS 410	Introduction to Electro-Optics	4
PHYS 436	Physics of the Performing Arts (PA)	3
PHYS 445	Image Analysis and Pattern Recognition	
	(COMP/MATH)	3
PHYS 464	Medical Instrumentation (BIOL).....	4
PHYS 490	Topics in Physics	3
PHYS 492	Internship	3
	(if not taken as a required course)	
PHYS 494†	Independent Research	1-3
PHYS 497†	Directed Studies	1-3
† Cannot exceed a total of 3 units, when added to units taken within the upper division requirements		
# Recommended for Teachers		
Required Supporting and Other GE Courses		
42 units		

American Institutions Requirement.....	6
Other courses in GE categories A-E	27
Electives in Any Discipline	9

Note: Courses with an asterisk (*) will double count with general education (GE) requirements. Only two upper division interdisciplinary GE major courses (numbered 330-349 and 430-449) may be used towards the upper division major GE requirement. The third course must come from outside the major.

Minor in Applied Physics - (25 units)

Applied physics focuses on the hi-tech applications of physics, and on developing technological skills. It applies a thorough analytic understanding of the principles to the complexities of real applications at the frontiers of science and technology, e.g. in imaging and computer vision, electronic instrumentation, and biomedical engineering. The Applied Physics Minor will equip you with the solid cross-disciplinary background that is highly valued by industry and academia.

Careers

The program gives you the opportunity to explore selected area(s) in greater depth, thus providing you with the depth and flexibility to explore a wide variety of career opportunities, including graduate study, medical school, teaching, imaging science, instrumentation, investments and technical management.

Faculty

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American Institutions Requirement.....	6
Other courses in GE categories A-E	27
Electives in Any Discipline	9

Minor in Applied Physics - (36 units)

Applied physics focuses on the hi-tech applications of physics, and on developing technological skills. It applies a thorough analytic understanding of the principles to the complexities of real applications at the frontiers of science and technology, e.g. in imaging and computer vision, electronic instrumentation, and biomedical engineering. The Applied Physics Minor will equip you with the solid cross-disciplinary background that is highly valued by industry and academia.

Careers

The program gives you the opportunity to explore selected area(s) in greater depth, thus providing you with the depth and flexibility to explore a wide variety of career opportunities, including graduate study, medical school, teaching, imaging science, instrumentation, investments and technical management.

Faculty

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Lower Division Requirements - 12 units

MATH	150*	Calculus I	4
PHYS	200*	General Physics I	4
PHYS	201*	General Physics II	4

Upper Division Requirements - 13 units**1. Applied Physics - 10-11 units**

PHYS	345*	Digital Image Processing (MATH/COMP)	3
PHYS	434*	Introduction to Biomedical Imaging (BIOL/HLTH)	4

Select either:

PHYS	445	Image Analysis and Pattern Recognition (MATH/COMP)	3
or			
PHYS	464	Medical Instrumentation (BIOL)	4

2. Applied Physics Electives - 2-3 units*Choose from:*

PHYS	490	Topics in Physics	3
PHYS	492	Internship	3
PHYS	494	Independent Research	1-3
PHYS	497	Directed Studies	1-3
PHYS	499	Senior Colloquium	1

Note:

* May be double counted toward GE requirements

Lower Division Requirements - 23 units

MATH	150	Calculus I	4
MATH	151	Calculus II	4
MATH	250	Calculus III	3
PHYS	200	General Physics I	4
PHYS	201	General Physics II	4
PHYS	202	General Physics III: Light, Relativity and Modern Physics	4

Upper Division Required Electives - 13 units*Choose 13 units from:*

PHYS	304	Electromagnetism	3	4
PHYS	306	Modern Physics	3	
PHYS	310	Electronics	4	
PHYS	335	The Physics of Music (PAMU)	3	
PHYS	345	Digital Image Processing (MATH/COMP)	3	
PHYS	405	Optics	4	
PHYS	410	Introduction to Electro-Optics	4	
PHYS	416	Radiobiology and Radionuclides (BIOL)	3	
PHYS	434	Introduction to Biomedical Imaging (BIOL/ HLTH)	4	
PHYS	445	Image Analysis and Pattern Recognition (MATH/COMP)	3	
PHYS	464	Medical Instrumentation (BIOL)	4	
PHYS	490	Topics in Physics	3	
PHYS	492	Internship	3	
PHYS	494	Independent Research	1-3	
PHYS	497	Directed Studies	1-3	
PHYS	499	Senior Colloquium	1	

Dr. Geoff Dougherty, Dr. Clint Harper, Dr. Greg Wood _____ 09/01/2015 _____
 Proposer of Program Modification Date

APPROVAL SHEET

Program: MATH and APPLIED PHYSICS

If your course has a General Education Component or involves Center affiliation, the Center will also sign off during the approval process.

Multiple Chair fields are available for cross-listed courses.

The CI program review process includes a report from the respective department/program on its progress toward accessibility requirement compliance. By signing below, I acknowledge the importance of incorporating accessibility in course design.

Program Chair Dr. Ivona Grzegorzczuk		
	Signature	Date

Curriculum Chair		
	Signature	Date

AVP		
	Signature	Date