Physics

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Bernard Gerstman, *Professor*
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Kenneth Hardy, *Professor Emeritus*
Jin He, *Associate Professor*
Kamal Kadel, *Instructor*
Laird H. Kramer, *Professor*
Angela Laird, *Professor*
Robert Laird, *Clinical Professor*
Hebin Li, *Associate Professor*
Wenzhi Li, *Professor*
Pete C. Markowitz, *Professor*
Oren Maxwell, *Professor Emeritus*
Stephan L. Mintz, *Professor Emeritus*
Rajamani Narayanan, *Professor*
Geoff Potvin, *Associate Professor*
Brian A. Raue, *Professor*
Jorge Reinhold, *Professor*
Jorge L. Rodriguez, *Associate Professor and Graduate Program Director*
Misak Sargsian, *Professor*
Caroline E. Simpson, *Professor*
Fiorella Terenzi, *Instructor*
Walter Van Hamme, *Professor*
Xuewen Wang, *Associate Professor*
James R. Webb, *Professor*
Yifu Zhu, *Professor*

Departmental information available at:
http://physics.fiu.edu

Bachelor of Science

Degree Program Hours: 120

The B.S. program in Physics prepares students for careers as professional physicists in industry, government, or graduate study in physics, engineering, or material science. It also prepares students for teaching careers. Students interested in teacher certification should contact the School of Education.

Lower Division Preparation

Common Prerequisite Courses and Equivalencies

FIU Course(s)	Equivalent Course(s)
CHM1045/CHM1045L	CHMX045C or CHMX040 & CHMX041 or CHMX045/X045L
CHM1046/CHM1046L	CHMX046C or CHMX046/046L
MAC2311	MACX311 or MACX281
MAC2312	MACX312 or MACX282
MAC2313	MACX313 or MACX283
PHY2048/2048L	PHYX048/X048L or PHYX048C
PHY2049/2049L	PHYX049/X049L or PHYX049C

Courses which form part of the statewide articulation between the State University System and the Florida College System will fulfill the Lower Division Common Prerequisites.

For generic course substitutions/equivalencies for Common Program Prerequisites offered at community colleges, state colleges, or state universities, visit: **http://www.flvc.org**, Search Program Listing by Alphabetic Order.

Required Courses

Common Prerequisites: (30)

CHM 1045	General Chemistry I	3
CHM 1045L	General Chemistry Lab I	1
CHM 1046	General Chemistry II	3
CHM 1046L	General Chemistry Lab II	1
MAC 2311	Calculus I	4
MAC 2312	Calculus II	4
MAC 2313	Multivariable Calculus	4
PHY 2048	Physics with Calculus I	4
PHY 2048L	General Physics Lab I	1
PHY 2049	Physics with Calculus II	4
PHY 2049L	General Physics Lab II	1

Students admitted to the university are admitted directly to their chosen major. Students are expected to make good progress based on critical indicators, such as GPA in specific courses or credits earned. In cases where students are not making good progress, a change of major may be required. Advisors work to redirect students to more appropriate majors when critical indicators are not met.

Additional Required Course: (4)

PHY 1033	Physics Pathways	1
MAP 2302	Differential Equations	3

Upper Division Program (60 total hours, 48 hours must be 3000 level or above)

Required Courses

PHY 3106	Modern Physics	3
PHY 3802L	Intermediate Physics Lab	3
PHZ 3113	Methods in Theoretical Physics	3
PHY 3513	Thermodynamics	3
PHY 4221	Introduction to Classical Mechanics	4
PHY 4323	Intermediate Electromagnetism I	3
PHY 4324	Intermediate Electromagnetism II	3
PHY 4604	Quantum Mechanics I	3
PHY 4605	Quantum Mechanics II	3
PHY 4821L	Advanced Physics Lab	3
Approved Physics Electives		9

Engineering Concentration

The program is designed for motivated students who have dual interests in physics and engineering. This program prepares undergraduate students for careers as professional physicists in industrial, university, and government laboratory settings. Students successfully completing this degree program will have satisfied the standard undergraduate requirements for admission to graduate programs in physics and engineering.

Lower Division Preparation

Common Prerequisite Courses and

Equivalencies

FIU Course(s)	Equivalent Course(s)
CHM1045/CHM1045L	CHMX045C or CHMX040 & CHMX041 or CHMX045/X045L
CHM1046/CHM1046L	CHMX046C or CHMX046/046L
MAC2311	MACX311 or MACX281
MAC2312	MACX312 or MACX282
MAC2313	MACX313 or MACX283
PHY2048/2048L	PHYX048/X048L or PHYX048C
PHY2049/2049L	PHYX049/X049L or PHYX049C

Courses which form part of the statewide articulation between the State University System and the Florida College System will fulfill the Lower Division Common Prerequisites.

For generic course substitutions/equivalencies for Common Program Prerequisites offered at community colleges, state colleges, or state universities, visit: **http://www.flvc.org**, Search Program Listing by Alphabetic Order.

Required Courses (34 credit hours)

Common Prerequisites: (30)

CHM 1045	General Chemistry I	3
CHM 1045L	General Chemistry Lab I	1
CHM 1046	General Chemistry II	3
CHM 1046L	General Chemistry Lab II	1
MAC 2311	Calculus I	4
MAC 2312	Calculus II	4
MAC 2313	Multivariable Calculus	4
PHY 2048	Physics with Calculus I	4
PHY 2048L	General Physics Lab I	1
PHY 2049	Physics with Calculus II	4
PHY 2049L	General Physics Lab II	1

Additional Required Course: (4)

PHY 1033	Physics Pathways	1
MAP 2302	Differential Equations	3

Upper Division Program (60 total hours, 48 hours must be 3000 level or above)

Required Courses

PHY 3106	Modern Physics	3
PHY 3802L	Intermediate Physics Lab	3
PHY 3513	Thermodynamics	3
PHY 4221	Introduction to Classical Mechanics	4
PHY 4323	Intermediate Electromagnetism I	3
PHY 4604	Quantum Mechanics I	3
PHY 4821L	Advanced Physics Lab	3
Approved Engineering Courses		18
Physics, Math, or Engineering Electives		12
Electives		8

Approved Engineering Courses

EEL 2880	Applied Software Techniques in Engineering	3
EEE 3303	Electronics I	3
EEE 3303L	Electronics I Laboratory	1
EEE 4202C	Medical Instrumentation Design	4
EEL 3110	Circuit Analysis	3
EEL 3110L	Circuits Lab	1
EEL 3120	Introduction to Linear Systems in Engineering	3
EEL 3135	Signals And Systems	3
EEL 3160	Computer Applications in Electrical Engineering	3
EEL 3712	Logic Design I	3
EEL 3712L	Logic Design I Lab	1
EEL 4213	Power Systems I	3
EEL 4213L	Energy Conversion Lab	1
EEL 4410	Introduction to Fields and Waves	3
EEL 4709C	Computer Design	3
EEL 4730	Programming Embedded Systems	3
EEL 4740	Embedded Computing Systems	3
EEL 4920	Senior Design I: Ethics, Communications, and Constraints	2
EEL 4921C	Senior Design II: Project Implementation	2
EIN 3235	Evaluation of Engineering Data I	3
EGN 3311	Statics	3
EGN 3321	Dynamics	3
EGN 3365	Materials in Engineering	3
EGN 3613	Engineering Economy	3
EMA 3702	Mechanics and Materials Science	3
EMA 3702L	Mechanics and Materials Science Lab	1
EML 3126	Transport Phenomena	3
EML 3222	Systems Dynamics	3
EML 3450	Energy Systems	3
EML 3500	Mechanical Design I	3
EML 4501	Mechanical Design II	3
EML 4140	Heat Transfer	3
EML 4702	Fluid Dynamics	3
EML 4706	Design of Thermal and Fluid Systems	3

Health Physics Concentration

The program is designed for those students who have interests in nuclear physics and the practical application of nuclear physics to modern society. This program prepares undergraduate students for careers as a nuclear worker in university, industrial, medical, and government laboratory settings. Students successfully completing this degree program will have satisfied the standard undergraduate requirements for admission to graduate programs in physics, medical physics, and health physics.

Lower Division Preparation

Common Prerequisite Courses and Equivalencies

FIU Course(s)	Equivalent Course(s)
CHM1045/CHM1045L	CHMX045C or CHMX040 & CHMX041 or CHMX045/X045L
CHM1046/CHM1046L	CHMX046C or CHMX046/046L
MAC2311	MACX311 or MACX281
MAC2312	MACX312 or MACX282
MAC2313	MACX313 or MACX283
PHY2048/2048L	PHYX048/X048L or PHYX048C
PHY2049/2049L	PHYX049/X049L or PHYX049C

Courses which form part of the statewide articulation between the State University System and the Florida College System will fulfill the Lower Division Common Prerequisites.

For generic course substitutions/equivalencies for Common Program Prerequisites offered at community colleges, state colleges, or state universities, visit:

http://www.flvc.org, Search Program Listing by Alphabetic Order.

Required Courses (38 credit hours)

Common Prerequisites: (30)

CHM 1045	General Chemistry I	3
CHM 1045L	General Chemistry Lab I	1
CHM 1046	General Chemistry II	3
CHM 1046L	General Chemistry Lab II	1
MAC 2311	Calculus I	4
MAC 2312	Calculus II	4
MAC 2313	Multivariable Calculus	4
PHY 2048	Physics with Calculus I	4
PHY 2048L	General Physics Lab I	1
PHY 2049	Physics with Calculus II	4
PHY 2049L	General Physics Lab II	1

Additional Required Course: (8)

PHY 1033	Physics Pathways	1
MAP 2302	Differential Equations	3
BSC 2010	General Biology I	3
BSC 2010L	General Biology I Lab	1

Upper Division Program (60 total hours, 48 hours must be 3000 level or above)

Required Courses

PHY 3106	Modern Physics	3
PHY 3802L	Intermediate Physics Lab	3
PHZ 3113	Methods in Theoretical Physics	3
PHY 3513	Thermodynamics	3
PHY 4221	Introduction to Classical Mechanics	4
PHY 4323	Intermediate Electromagnetism I	3
PHY 4324	Intermediate Electromagnetism II	3
PHY 4604	Quantum Mechanics I	3
PHY 4605	Quantum Mechanics II	3
PHY 4821L	Advanced Physics Lab	3
PHZ 3360	Introduction to Radiation Protection	1
PHZ 3308	Applications of Nuclear Physics	3
PHZ 3361	Radiation Detection and Measurement	3
PHZ 4731	Introduction to Health Physics	3
Electives		19

Recommended Electives

PHZ 4710	Introduction to Biophysics	3
PCB 3063	Genetics	3
PCB 3063L	Genetics Lab	1
PCB 4023	Cell Biology	3

Physics Education Track (FIUteach)

This program prepares students interested in physics graduate school as well as certification to teach physics at the secondary level. Students are encouraged to contact the FIUteach program (FIUteach.fiu.edu) for opportunities to try out teaching at no cost. Interested students are encouraged to contact the department, the FIUteach program, or the secondary science advisor for additional details and certification requirements.

Lower Division Preparation

Common Prerequisite Courses and Equivalencies

FIU Course(s)	Equivalent Course(s)
CHM1045/CHM1045L	CHMX045C or CHMX040 & CHMX041 or CHMX045/X045L
CHM1046/CHM1046L	CHMX046C or CHMX046/046L
MAC2311	MACX311 or MACX281
MAC2312	MACX312 or MACX282
MAC2313	MACX313 or MACX283
PHY2048/2048L	PHYX048/X048L or PHYX048C
PHY2049/2049L	PHYX049/X049L or PHYX049C

Courses which form part of the statewide articulation between the State University System and the Florida College System will fulfill the Lower Division Common Prerequisites.

For generic course substitutions/equivalencies for Common Program Prerequisites offered at community colleges, state colleges, or state universities, visit: http://www.flvc.org, See Common Prerequisite Manual.

Common Prerequisites as Detailed Under the B.S. Degree

Additional Lower Division Courses: (6)

BSC 2010	General Biology I	3
BSC 2010L	General Biology I Lab	1
and		
SMT 2661	Step 1: Inquiry Approaches to Teaching Mathematics and Science	1
SMT 2662	Step 2: Inquiry-Based Lesson Design in Mathematics and Science	1
or		
SMT 2044	Combined STEP 1 & 2: Inquiry-Based Approaches and Lesson Design for Teaching	2

Upper Division Program (60 total hours, 48 hours must be 3000 level or above)

PHY 3106	Modern Physics	3
PHY 3802L	Intermediate Physics Lab	3
PHZ 3113	Methods in Theoretical Physics	3
PHY 3513	Thermodynamics	3
PHY 4221	Introduction to Classical Mechanics	4
PHY 4323	Intermediate Electromagnetism I	3
PHY 4604	Quantum Mechanics I	3
PHY 4821L	Advanced Physics Lab	3
PHY 3018	Research Methods in Physics	3
SMT 3100	Knowing and Learning in Mathematics and Science	3
SMT 4301	Classroom Interactions in Mathematics and Science Teaching	3
SMT 4664	Problem-Based Instruction (PBI) in Mathematics and Science	3
SCE 4194	Perspectives in Science and Math Education	3
SCE 4944	Student Teaching	6
RED 4325	Subject Area Reading	3
TSL 4324	ESOL Issues and Strategies for Content Teachers – *GL*	3
Physics Electives or required courses		8

Students encouraged to take PHY 4324 Intermediate Electromagnetism II and PHY 4605 Quantum Mechanics II if continuing onto physics graduate school.

Bachelor of Science with Honors in Physics

The Honors program in Physics provides outstanding students with the opportunity to do original research with a

faculty sponsor. To graduate with Honors, the student must carry out a research project, write up the project as an Honors Thesis, and present the research results in a departmental seminar.

Admission to the Program

To be admitted to the track, a student must:

- Be admitted to the BS Physics program with a lower division GPA of at least 3.5 in science and math courses and an overall GPA of at least 3.2.
- Have completed at least 12 hours of physics courses.
- Have arranged to be sponsored by a faculty researcher.
- Submit a letter to the Physics Department requesting permission to pursue the honors course of study.

Graduation Requirements

1. Completion of all requirements for the BS Physics degree with a minimum GPA of 3.5 in science and math courses and overall GPA of 3.2.
2. Completion of honors research project in collaboration with a faculty advisor. The results of the research project must be written in the form of an honors thesis which is written in American Physical Society-style publication format. The faculty advisor and curriculum committee must judge the thesis as suitable in style and content.
3. Submission of two completed and approved copies of the Honors Thesis must be presented to the Physics department office; one copy is to be kept in the department and the second copy is to be housed in the University library.
4. The results of the research project must be presented orally to an audience of peers and faculty members in a departmental seminar.

Bachelor of Arts

Degree Program Hours: 120

This program prepares students interested in physics and planning to enter professional schools in business, education, journalism, law, and medicine, and for liberal arts students desiring a strong background in physical science but with career objectives in other areas. The flexible program offers the opportunity for parallel studies in another discipline and/or pre-professional preparation. Students may choose to follow the standard B.A. or choose a specific area of emphasis: the Biophysics Concentration, the Business Concentration, or the Entrepreneurship Concentration. Students wishing to pursue careers as professional physicists or graduate study in physics should seek the Bachelor of Science degree in physics.

Lower Division Preparation for all areas of Concentration

Common Prerequisite Courses and Equivalencies

FIU Course(s)	Equivalent Course(s)
CHM1045/CHM1045L	CHMX045C or CHMX040 & CHMX041 or CHMX045/X045L
CHM1046/CHM1046L	CHMX046C or CHMX046/046L
MAC2311	MACX311 or MACX281
MAC2312	MACX312 or MACX282
MAC2313	MACX313 or MACX283
PHY2048/2048L	PHYX048/X048L or PHYX048C
PHY2049/2049L	PHYX049/X049L or PHYX049C

Courses which form part of the statewide articulation between the State University System and the Florida College System will fulfill the Lower Division Common Prerequisites.

For generic course substitutions/equivalencies for Common Program Prerequisites offered at community colleges, state colleges, or state universities, visit: **http://www.flvc.org**, Search Program Listing by Alphabetic Order.

Required Courses: (30)

Common Prerequisites

CHM 1045	General Chemistry I	3
CHM 1045L	General Chemistry Lab I	1
CHM 1046	General Chemistry II	3
CHM 1046L	General Chemistry Lab II	1
MAC 2311	Calculus I	4
MAC 2312	Calculus II	4
MAC 2313	Multivariable Calculus	4
PHY 2048	Physics with Calculus I	4
PHY 2048L	General Physics Lab I	1
PHY 2049	Physics with Calculus II	4
PHY 2049L	General Physics Lab II	1

Additional Required Course: (4)

PHY 1033	Physics Pathways	1
MAP 2302	Differential Equations	3

Upper Division Program for the B.A. (60 total hours, 48 hours must be 3000 level or above)

PHY 3106	Modern Physics	3
PHY 3802L	Intermediate Physics Lab	3
PHY 3513	Thermodynamics	3
	or	
PHZ 3113	Methods in Theoretical Physics	3
PHY 4221	Introduction to Classical Mechanics	4
PHY 4821L	Advanced Physics Lab	3
Physics Electives		15
Electives		29

Biophysics Concentration

This program prepares students interested in physics and planning to enter professional schools in medicine, biomedical engineering, and biomechanics as well as entry level biotechnology positions in industry and government. The flexible program offers the opportunity for parallel studies in another discipline. Students satisfying the degree requirements of this program will also have satisfied the course requirement for admission to medical schools. Interested students should consult the Premedical advisor at (305) 348-3084.

Lower Division Preparation

Common Prerequisite Courses and Equivalencies

FIU Course(s)	Equivalent Course(s)

CHM1045/CHM1045L	CHMX045C or CHMX040 & CHMX041 or CHMX045/X045L
CHM1046/CHM1046L	CHMX046C or CHMX046/046L
MAC2311	MACX311 or MACX281
MAC2312	MACX312 or MACX282
MAC2313	MACX313 or MACX283
PHY2048/2048L	PHYX048/X048L or PHYX048C
PHY2049/2049L	PHYX049/X049L or PHYX049C

Courses which form part of the statewide articulation between the State University System and the Florida College System will fulfill the Lower Division Common Prerequisites.

For generic course substitutions/equivalencies for Common Program Prerequisites offered at community colleges, state colleges, or state universities, visit: **http://www.flvc.org**, Search Program Listing by Alphabetic Order.

Common Prerequisites as Detailed Under the B.A. Degree

Additional Required Courses: (4)

PHY 1033	Physics Pathways	1
MAP 2302	Differential Equations	3

Additional Lower Division Courses: (17)

BSC 2010	General Biology I	3
BSC 2010L	General Biology I Lab	1
BSC 2011	General Biology II	3
BSC 2011L	General Biology II Lab	1
CHM 2210	Organic Chemistry I	4
CHM 2210L	Organic Chemistry I Lab	1
CHM 2211	Organic Chemistry II	3
CHM 2211L	Organic Chemistry II Lab	1

Upper Division Program (60 total hours, 48 hours must be 3000 level or above)

PHY 3106	Modern Physics	3
PHY 3802L	Intermediate Physics Lab	3
PHY 3513	Thermodynamics	3
	or	
PHZ 3113	Methods in Theoretical Physics	3
PHY 4221	Introduction to Classical Mechanics	4
PHY 4821L	Advanced Physics Lab	3
PHZ 4710	Introduction to Biophysics	3
Physics Electives		12
Electives in Biology and Chemistry		12
Electives		17

Pre-med students are strongly encouraged to take:

BCH 3033	General Biochemistry	4
BCH 3033L	General Biochemistry Lab	1
	or	
CHM 4304	Biological Chemistry I	3
CHM 4304L	Biological Chemistry I Lab	1
PCB 3063	Genetics	3
PCB 3063	Genetics Lab	1
PCB 3702	Intermediate Human Physiology	3
PCB 3702L	Intermediate Human Physiology Lab	1

Business Concentration

This program prepares students interested in physics and planning to enter business and business management careers. Concentrates on the basics of business administration and on gaining a thorough understanding of electronics, lasers, computers and other tools of the physicist.

Lower Division Preparation

Common Prerequisite Courses and Equivalencies

FIU Course(s)	Equivalent Course(s)
CHM1045/CHM1045L	CHMX045C or CHMX040 & CHMX041 or CHMX045/X045L
CHM1046/CHM1046L	CHMX046C or CHMX046/046L
MAC2311	MACX311 or MACX281
MAC2312	MACX312 or MACX282
MAC2313	MACX313 or MACX283
PHY2048/2048L	PHYX048/X048L or PHYX048C
PHY2049/2049L	PHYX049/X049L or PHYX049C

Courses which form part of the statewide articulation between the State University System and the Florida College System will fulfill the Lower Division Common Prerequisites.

For generic course substitutions/equivalencies for Common Program Prerequisites offered at community colleges, state colleges, or state universities, visit: **http://www.flvc.org**, Search Program Listing by Alphabetic Order.

Common Prerequisites as Detailed Under the B.A. Degree

Additional Required Courses: (4)

PHY 1033	Physics Pathways	1
MAP 2302	Differential Equations	3

Additional Lower Division Courses: (9)

ECO 2013	Principles of Macroeconomics	3
ECO 2023	Principles of Microeconomics	3
ACG 2021	Accounting for Decisions	3

Upper Division Program (60 total hours, 48 hours must be 3000 level or above)

PHY 3106	Modern Physics	3
PHY 3802L	Intermediate Physics Lab	3
PHY 3513	Thermodynamics	3
	or	
PHZ 3113	Methods in Theoretical Physics	3
PHY 4221	Introduction to Classical Mechanics	4
PHY 4821L	Advanced Physics Lab	3
Physics Electives		15
ACG 3301	Acc. for Planning and Control	3
CGS 3300	Introduction to Information Systems	3
FIN 3403	Financial Management	3
MAN 3025	Organization and Management	3
MAN 4602	International Business	3
MAR 3023	Introduction to Marketing– *GL*	3
Business Electives		3
Electives		8

Entrepreneurship Concentration

This program provides students with a strong background in physics as well as the skill set for starting and growing new high-tech business ventures. The curriculum encourages "hands on" interdisciplinary research in the form of an independent study course and an entrepreneurial science internship. It also provides the flexibility to tailor coursework to science and technology entrepreneurial activities. Graduates of this program will be well equipped to create their own high-tech jobs within existing companies as well as their own startup ventures.

Lower Division Preparation

Common Prerequisite Courses and Equivalencies

FIU Course(s)	Equivalent Course(s)
CHM1045/CHM1045L	CHMX045C or CHMX040 & CHMX041 or CHMX045/X045L
CHM1046/CHM1046L	CHMX046C or CHMX046/046L
MAC2311	MACX311 or MACX281
MAC2312	MACX312 or MACX282
MAC2313	MACX313 or MACX283
PHY2048/2048L	PHYX048/X048L or PHYX048C
PHY2049/2049L	PHYX049/X049L or PHYX049C

Courses which form part of the statewide articulation between the State University System and the Florida College System will fulfill the Lower Division Common Prerequisites.

For generic course substitutions/equivalencies for Common Program Prerequisites offered at community colleges, state colleges, or state universities, visit: **http://www.flvc.org**, Search Program Listing by Alphabetic Order.

Common Prerequisites as Detailed Under the B.A. Degree

Additional Required Courses: (4)

PHY 1033	Physics Pathways	1
MAP 2302	Differential Equations	3

Upper Division Program (60 total hours, 48 hours must be 3000 level or above)

PHY 3106	Modern Physics	3
PHY 3802L	Intermediate Physics Lab	3
PHY 3513	Thermodynamics	3
	or	
PHZ 3113	Methods in Theoretical Physics	3
PHY 4221	Introduction to Classical Mechanics	4
PHY 4323	Intermediate Electromagnetism I	3
PHY 4604	Quantum Mechanics I	3
PHY 4821L	Advanced Physics Lab	3
Physics Electives		9
ENT 4113	Entrepreneurship: New Business Development	3
ISC 4947	Entrepreneurial Science Internship	3
GEB 4110	Writing the Business Plan	3
	or	
GEB 4xxx	Technology Product and Service Development	3
Electives		20

Physics Education Track (FIUteach)

This program prepares students interested in physics careers and certification to teach physics. Additional science and/or mathematic certifications at the secondary level may be added (below). Students are encouraged to contact the FIUteach program (**FIUteach.fiu.edu**) for opportunities to try out teaching at no cost. Interested students are encouraged to contact the department, the FIUteach program, or the secondary science advisor for additional details and certification requirements.

Additional coursework in science and/or mathematics is required to prepare for certification in additional subject areas. Students must contact the FIUteach program or the secondary science advisor for details and requirements.

Lower Division Preparation

Common Prerequisite Courses and Equivalencies

FIU Course(s)	Equivalent Course(s)
CHM1045/CHM1045L	CHMX045C or CHMX040 & CHMX041 or CHMX045/X045L
CHM1046/CHM1046L	CHMX046C or CHMX046/046L
MAC2311	MACX311 or MACX281
MAC2312	MACX312 or MACX282
MAC2313	MACX313 or MACX283
PHY2048/2048L	PHYX048/X048L or PHYX048C
PHY2049/2049L	PHYX049/X049L or PHYX049C

Courses which form part of the statewide articulation between the State University System and the Florida College System will fulfill the Lower Division Common Prerequisites.

For generic course substitutions/equivalencies for Common Program Prerequisites offered at community colleges, state colleges, or state universities, visit: **http://www.flvc.org**, Search Program Listing by Alphabetic Order.

Common Prerequisites as Detailed Under the B.A. Degree

Additional Lower Division Courses: (8)

BSC 2010	General Biology I	3
BSC 2010L	General Biology I Lab	1
and		
SMT 2661	Step 1: Inquiry Approaches to Teaching Mathematics and Science	1
SMT 2662	Step 2: Inquiry-Based Lesson Design in Mathematics and Science	1
or		
SMT 2044	Combined STEP 1 & 2: Inquiry-Based Approaches and Lesson Design for Teaching Mathematics and Science	2

Upper Division Program (60 total hours, 48 hours must be 3000 level or above)

PHY 3106	Modern Physics	3
PHY 3802L	Intermediate Physics Lab	3
PHY 3107	Advanced Modern Physics	3
PHY 3513	Thermodynamics	3
PHY 4221	Introduction to Classical Mechanics	4
PHY 4821L	Advanced Physics Lab	3
PHY 3018	Research Methods in Physics	3

SMT 3100	Knowing and Learning in Mathematics and Science	3
SMT 4301	Classroom Interactions in Mathematics and Science Teaching	3
SMT 4664	Problem-Based Instruction (PBI) in Mathematics and Science	3
SCE 4194	Perspectives in Science and Math Education	3
SCE 4944	Student Teaching	6
RED 4325	Subject Area Reading	3
TSL 4324	ESOL Issues and Strategies for Content Teachers – *GL*	3
Electives		8

Minor in Physics

This program is designed for students who desire additional capabilities in physics beyond the basic sequence. This program is especially recommended for chemistry, mathematics, and engineering/technology majors.

PHY 2048	Physics with Calculus I	4
PHY 2048L	General Physics Lab I	1
PHY 2049	Physics with Calculus II	4
PHY 2049L	General Physics Lab II	1
PHY 3106	Modern Physics	3
PHY 3802L	Intermediate Physics Lab	3
Approved physics electives		3

Minor in Astronomy

This program is designed for students who desire additional capabilities in astronomy. The program offers enhanced preparation for graduate studies in astronomy and astrophysics. It is also aimed at students interested in careers in science education, science centers, musea, and planetaria.

PHY 2048	Physics with Calculus I	4
PHY 2048L	Physics with Calculus Lab I	1
PHY 2049	Physics with Calculus II	4
PHY 2049L	Physics with Calculus Lab II	1
PHY 3106	Modern Physics	3
AST 3213	Modern Astrophysics	3
AST 3722	Observational Astronomy	3
AST 3722L	Observational Astronomy Lab	1

Cooperative Education

Students seeking the baccalaureate degree in physics may also take part in the Cooperative Education Program conducted in conjunction with Career Planning & Placement. The student spends several semesters fully employed in an industrial or governmental physics laboratory. For further information consult the Department of Physics or Career Planning & Placement.

Course Descriptions

Definition of Prefixes

AST-Astronomy; ENU-Engineering: Nuclear; MET-Meteorology; PHY-Physics; PHZ-Physics; PSC-Physical Sciences

F-Fall semester offering; S-Spring semester offering; SS-Summer semester offering.

AST 1002 Descriptive Astronomy (3). An introductory survey of our universe. Topics include the formation and evolution of the universe, including planets, stars, galaxies, and black holes.

AST 1002L Descriptive Astronomy Lab (1). Laboratory course to accompany AST 1002. An introduction to experimental work in astronomy including laboratory exercises during the day in the lab and evening observating sessions. Prerequisite/Corequisite: AST 1002.

AST 2003 Solar System Astronomy (3). General principles of Astronomy with emphasis on the structure and evolution of the Solar System, the laws of planetary motion, and the physical aspects of the sun, planets, and interplanetary debris. (F,S,SS)

AST 2003L Solar System Astronomy Laboratory (1). Laboratory section of AST 2003. Outdoor observing of the moon, planets and indoor exercises including celestial positions and time, the moon's orbit, planetary motions, comparative planetology. Corequisite: AST 2003. (Lab fees assessed) (F,S,SS)

AST 2004 Stellar Astronomy (3). General principles of Astronomy with emphasis on the structure and evolution of stars, stellar systems, galaxies and the universe. Topics include stellar birth and death, neutron stars and black holes, galactic distances and the expansion of the universe. (F,S,SS)

AST 2004L Stellar Astronomy Laboratory (1). Laboratory section of AST 2004. Outdoor observing of stars, constellations, binary and variable stars, star clusters, nebulae and indoor exercises including radiative properties of the stars, spectra, stellar and galactic distances, Hubble's Law. Corequisite: AST 2004. (Lab fees assessed) (F,S,SS)

AST 2037 Intelligent Life in the Universe (3). Examines the possibility of extraterrestrial life in terms of the probability of the existence of planets in other solar systems, the conditions necessary for life, and means of communication. (F or S)

AST 3213 Modern Astrophysics (3). An introduction to the structure of stars and galaxies and the evolution of the universe as a whole. Topics will include atomic spectra, stellar classifications, galactic structure, and cosmology. Prerequisites: PHY 2048, 2049. (F or S)

AST 3722 Observational Astronomy (3). Observational astronomical techniques from radio to x-rays including CCD Imaging, Photometry, and Spectroscopy. Prerequisite: PHY 2049.

AST 3722L Observational Astronomy Laboratory (1). The lab component associated with Observational Astronomy. Covers acquisition, reduction and interpretation of astronomical data using telescopes and computers. Corequisite: AST 3722.

AST 5215 Stellar Astrophysics (3). Topics in Stellar Astrophysics, in greater detail and depth than similar topics in AST 3213. Emphasis on current stellar structure, evolution models and the underlying observational data. Prerequisites: PHY 3107, PHY 3513, PHY 4324, PHY 4222 or equivalent. (F or S)

AST 5405 Extragalactic Astrophysics (3). Topics in extragalactic astrophysics, in greater detail and depth than similar topics in AST 3213. Emphasis on galactic structure and evolution, quasars and cosmology. Prerequisites: PHY 3107, PHY 3513, PHY 4324, PHY 4222 or equivalent. (F or S)

AST 5507 Celestial Mechanics (3). Principles of classical Newtonian mechanics applied to the motions of planets, satellites, and interplanetary space probes. Prerequisites: PHY 4222 or equivalent. (F or S)

ENU 4101 Introduction to Nuclear Reactors (3). An elementary course in nuclear fission reactor theory and power plant operation. An overview of the relevant nuclear processes and their application to reactor design. Prerequisites: PHY 2048, PHY 2049.

MET 2010 Meteorology and Atmospheric Physics (3). Physics of the Earth's atmosphere and weather including energy and heat transfer, radiation, temperature and pressure changes and the development of storms, atmospheric optical effects, and weather forecasting. Prerequisite: High school algebra. (F,S)

MET 2010L Meteorology and Atmospheric Physics Laboratory (1). Practical weather analysis including fronts, local severe weather, hurricanes, also elementary analyses and interpretation of weather maps, satellite imagery, radar data. Corequisite: MET 2010. (F,S)

PHY 1020 Understanding the Physical World (3). A course to introduce non-science majors to the basic principles of the physical world with emphasis on understanding common devices, biological and medical applications, natural phenomena and sports. Prerequisite: one year high school or college algebra. (F,S)

PHY 1020L Understanding the Physical World Laboratory (1). Laboratory section of Understanding the Physical World. (F,S)

PHY 1033 Physics Pathways (1). Introduces activities, members, research and facilities of the Physics Department, curriculum choices, and physics career options to freshman through group discussions and faculty seminars. Repeatable for credit.

PHY 1037 Quarks, Superstrings, and Black Holes (3). Introduction to physics in the modern era for nonscientists. Topics include quantum mechanics, relativity, fundamental forces, and unification theory.

PHY 1037L Quarks, Superstrings, and Black Holes Laboratory (1). Laboratory to accompany Quarks, Superstrings, and Black Holes.

PHY 2023 Survey of General Physics (3). Units, quantities, Newton's laws, work, momentum, fluids, heat, gas laws, waves, charge and current, electric fields, circuits, light, atomic and nuclear physics. Prerequisites: Algebra, trigonometry (high school). (F,S,SS)

PHY 2048 Physics with Calculus I (4). First in physics with calculus sequence. Covers kinematics, Newton's Laws, conservations laws, gravitation, fluids, sound, and thermodynamics. PHZ 2102 strongly recommended for problem solving skills. Calculus I (MAC 2311 or equivalent) should be taken prior to or concurrent with this course. Prerequisite or Corequisite: MAC 2311 or equivalent.

PHY 2048L General Physics Laboratory I (1). Laboratory sections of PHY 2048, PHY 2049, PHY 2053, PHY 2054. Prerequisites or Corequisites: PHY 2048, PHY 2049, PHY 2053, PHY 2054. (Lab fees assessed) (F,S,SS)

PHY 2049 Physics with Calculus II (4). Second in basic physics with calculus sequence. Covers electricity and magnetism, field theory, geometrical and wave optics. PHZ 2103 strongly recommended for problem solving skills. Calculus II (MAC 2312 or equivalent) should be taken prior to or concurrent with this course. Prerequisites: PHY 2048. Prerequisite or Corequisite: MAC 2312. (F,S,SS)

PHY 2049L General Physics Laboratory II (1).). Laboratory sections of PHY 2048, PHY 2049, PHY 2053, PHY 2054. Prerequisites or Corequisites: PHY 2048, PHY 2049, PHY 2053, PHY 2054. (Lab fees assessed) (F,S,SS)

PHY 2053 Physics without Calculus I (4). First in physics without calculus sequence. Covers kinematics, Newtonian mechanics, properties of fluids, thermodynamics, and wave motion. PHY 2065 strongly recommended for problem solving skill. Trigonometry (MAC 1114 or equivalent) should be taken prior to or concurrently with this course.

PHY 2054 Physics without Calculus II (4). Second in basic physics without calculus sequence. Covers electricity and magnetism, geometrical and wave optics and the structure of matter. PHY 2166 strongly recommended for problem solving skills. Prerequisite: PHY 2053. (F,S,SS)

PHY 2065 Problem Solving in Physics without Calculus I (1). Supplemental course for Physics 2053 that teaches problem solving skills and reinforces concepts learned in the lecture. Corequisite: PHY 2053.

PHY 2166 Problem Solving in Physics without Calculus II (1). Supplemental course for Physics 2054 that teaches problem solving skills and reinforces concepts learned in the lecture. Corequisite: PHY 2054.

PHY 3012 Seminar in Physics Education (1). Physics education theory, pedagogy, and practice for those considering physics education careers. Covers conceptual development, collaborative learning, and assessment in multiple physics topics.

PHY 3018 Research Methods in Physics (3). Experimental development and design for future physics teachers. Four independent physics experiments are designed, conducted and analyzed. Includes statistical analysis techniques. Prerequisite: SMT 2662.

PHY 3106 Modern Physics (3). Development of modern physics. Topics include: special relativity, wave-particle duality, origins of quantum mechanics, and the Schrodinger wave equation. Prerequisites: PHY 2049 (F)

PHY 3106L Modern Physics Laboratory I (1). Laboratory courses to accompany Modern Physics I consisting of experiments in atomic and nuclear physics. Pre- or Corequisites: PHY 3106. (F)

PHY 3107 Advanced Modern Physics (3). Applications of Modern Physics. Topics include: the hydrogen atom, atomic physics, molecular physics, nuclear structure, nuclear instrumentation, and elementary particle physics. Prerequisite: PHY 3106. (S)

PHY 3107L Modern Physics Laboratory II (1). Laboratory courses to accompany Modern Physics II consisting of experiments in atomic and nuclear physics. Pre- or Corequisites: PHY 3107. (S)

PHY 3272 Physics of Space Flight (3). Basic physics is used to describe the motions of space craft, with a discussion of various types of propulsion systems, including chemical methods, nuclear systems, electric and photon propulsion. Prerequisite: PHY 2049.

PHY 3424 Optics (3). General formulation of geometrical optics including matrix techniques, interference phenomena, and the theory of Fraunhofer and Fresnel diffraction are among the topics covered. Prerequisites: PHY 2049.

PHY 3465 Physics of Music (3). Provides an understanding of the physics behind sound, sound reproduction and electronics that are necessary for musicians to understand to take full advantage of modern electronic and musical equipment.

PHY 3513 Thermodynamics (3). Fundamental principles of thermodynamics, the first, second, and third laws, free energy, entropy, the chemical potential, phase rule and its applications. Prerequisites: PHY 2049, MAC 2313. Corequisite: MAC 2313. (F)

PHY 3722 Electronics (3). Solid state theory and the theory of circuits, circuit operation and design in lecture and laboratory sessions. Prerequisites: PHY 2048, PHY 2049.

PHY 3802L Intermediate Physics Lab (3). Experiments covering physics topics from the 20th century are performed, analyzed, and discussed. An introduction to modern physics equipment, and techniques of data reduction and error analysis. Corequisite: PHY 3106.

PHY 3949, PHY 4949 Cooperative Education in Physics (1-3). One semester of full-time supervised work in an outside laboratory taking part in the University Co-op Program. Limited to students admitted to the Co-op Program. A written report and supervisor evaluation will be required of each student. (F,S,SS)

PHY 4134 Widely Applied Physics I (3). Applications of Physics principles to a diverse set of phenomena. Topics include material science, computers and electronics, nuclear physics and energy, astrophysics, aeronautics and space flight, communication technology, and medical physics and imaging. Prerequisite: PHY 3106.

PHY 4135 Widely Applied Physics II (3). Second of a two-course sequence. Will investigate materials science, nanotechnology, computers and electronics, nuclear physics and energy, astrophysics, aeronautics and space flight, communications technology, meteorology, and medical physics and imaging. Course will focus on Chaos, Optical and Wireless Communications, High Temperature Superconductors. Prerequisite: PHY 3106.

PHY 4221 Introduction to Classical Mechanics (4). An introduction to classical mechanics. Topics include: Newton's laws, particle dynamics, central forces, oscillatory motion, Lagrangian and Hamiltonian mechanics, system and rigid body dynamics. Prerequisites: PHY 2049, MAC 2313. (F)

PHY 4222 Advanced Classical Mechanics (3). Lagrangian and Hamiltonian mechanics, rigid body dynamics, coupled oscillators and normal modes, nonlinear dynamics and chaos, collision theory, continuum mechanics, and special relativity. Prerequisite: PHY 4221. (S)

PHY 4323 Intermediate Electromagnetism I (3). The theory of electromagnetic fields and waves is developed from basic principles. Vector calculus, Coulomb's law, Gauss's Law, electrostatic potential, dielectrics, solutions to Laplace's and Poisson's equations, magnetic induction, vector potential, magnetic materials, Maxwell's equations, and propagation of waves in space and various media are discussed. Prerequisites: PHY 2049, MAC 2313. Prerequisite or Corequisite: MAP 2302. (F)

PHY 4324 Intermediate Electromagnetism II (3). The theory of electromagnetic fields and waves is developed from basic principles. Vector calculus, Coulomb's law, Gauss's Law, electrostatic potential, dielectrics, solutions to Laplace's and Poisson's equations, magnetic induction, vector potential, magnetic materials, Maxwell's equations, and propagation of waves in space and various media are discussed. Prerequisite: PHY 4323. (S)

PHY 4513 Statistical Thermodynamics (3). Review of the fundamental laws of thermodynamics applied to simple systems. Elementary kinetic theory of gases applied to diffusion, viscosity, thermal and electrical conductivity. Boltzmann, Fermi-Dirac and Bose-Einstein distribution functions applied in the Boltzmann limit to the calculation of thermodynamic variables. Prerequisites: MAC 2313, PHY 2048, PHY 2049.

PHY 4604 Quantum Mechanics I (3). A comprehensive introduction to quantum mechanics. Wave mechanics applied to standard one dimensional problems and the hydrogen atom. Prerequisites: MAP 2302, PHY 3106 and PHY 3107. (F)

PHY 4605 Quantum Mechanics II (3). General matrix formalism, angular momentum, symmetries, perturbation theory and variational methods, an introduction to relativistic theory and theory of fields. Prerequisite: PHY 4604. (S)

PHY 4752C Introduction to Scientific Instrumentation (3). The student learns to set up and operate such standard pieces of laboratory apparatus as bridges, amplifiers, oscilloscopes, frequency counters, flowmeters, and thermocouple circuits utilizing chart recorders. A background in general physics is required.

PHY 4821L Advanced Physics Lab (3). Advanced laboratory topics are treated. Modern physics laboratory equipment is used and the student is introduced to current laboratory practice. Prerequisites: MAC 2313, PHY 3802L. (S)

PHY 4905, PHY 4906, PHY 4907 Independent Study (1-20). The student works under the supervision of a faculty member on subject matter of mutual interest. Instructor's permission is required.

PHY 4936, PHY 4937, PHY 4938 Special Topics (VAR). A study of topics of special physics interest.

PHY 5115 Mathematical Physics I (3). Methods of solution for problems in mathematical physics: Variational principles, complex variables, partial differential equations, integral equations, and transforms. Prerequisites: MAC 2313, MAP 2302. (F)

PHY 5116 Mathematical Physics II (3). Additional solution methods in mathematical physics: Perturbation methods, Laplace's and Poisson's Equations, waves, special functions, vector fields, vector waves. Prerequisite: PHY 5115. (S)

PHY 5141 Intermediate Modern Physics I (3). Prepares advanced undergraduate and beginning graduate students to start research in atomic, molecular, or optical physics. Topics may be adapted to students' research interests. Prerequisite: Permission of the instructor.

PHY 5142 Intermediate Modern Physics II (3). Continuation of advanced undergraduate and beginning graduate student research preparation in atomic, molecular, optical or nuclear physics. Topics may be adapted to students' research interests. Prerequisite: PHY 5141.

PHY 5156C Physics Modeling II (4). Expanding the modeling guided-inquiry approach in Physics Modeling I to topics beyond mechanics such as electricity, magnetism, light, or modern physics. May be repeated for credit. Prerequisites: PHZ 5155C and permission of the instructor.

PHY 5235 Nonlinear Dynamics and Chaos (3). Introduction to the universal behavior of classical systems described by nonlinear equations. Prerequisites: PHY 4222, MAA 4211. (F or S)

PHY 5240 Advanced Classical Mechanics (3). Advanced formulations of the equations of motion and their applications: the central field problem, rigid body dynamics, oscillations and continuous systems. Prerequisite: PHY 4222. (F)

PHY 5346 Advanced Electromagnetic Theory I (3). Advanced treatment of classical electromagnetism: Electrostatics, Green's function, Laplace's equation, multipole expansion, magnetostatics, Maxwell's equations, waves. Prerequisite: PHY 4324. (F)

PHY 5347 Advanced Electromagnetic Theory II (3). Additional topics in classical electromagnetism: Wave guides, radiating and diffracting systems, Kirchoff's integral for diffraction, covariant formulation of field equations. Prerequisite: PHY 5346. (S)

PHY 5446 Laser Physics (3). Principles of lasers and laser applications, including atom-field interactions, stimulated emission and dipole oscillators, optical resonators and electromagnetic modes, semi-classical laser theory, and specific laser systems. Prerequisite: PHY 4605. (F or S)

PHY 5466 The Physics of Music (3). Provides music technology majors a physical understanding of sound, sound generation and reproduction. Concentrates mainly on physical principles and less on calculation. Prerequisite: Permission of the instructor.

PHY 5667 Nonperturbative Quantum Field Theory (3). Euclidean QFT, renormalization group, local gauge symmetry, lattice regularization, Wilson action, fermion fields, expansion schemes, numerical algorithms, hadron properties, recent developments. Prerequisite: PHY 4605.

PHY 5930 Seminar in Physics (1-3). A series of specialized lectures/seminars on selected topics in Physics/Astro-Physics. Prerequisite: Permission of the department.

PHY 5936 Special Topics Research (1-10). Participation in an original investigation in theoretical or experimental physics/astro-physics under direct faculty supervision. Prerequisite: Permission of the instructor.

PHY 5937, PHY 5938 Seminar in Special Topics (3). Seminar work under the supervision of a faculty member on subject material of mutual interest.

PHY 5940 Physics Graduate Teaching Workshop (1). The teaching of physics laboratories. Includes practice of lab experiments, use and adjustment of lab equipment and explanation of departmental grading policy. Supplemented by outside lectures on university policies. (F)

PHZ 2102 Problem Solving in Physics I (1). Supplemental course for Physics 2048 that teaches problem solving skills and reinforces concepts learned in the lecture. Corequisite: PHY 2048.

PHZ 2103 Problem Solving in Physics II (1). Supplemental course for Physics 2049 that teaches problem solving skills and reinforces concepts learned in the lecture. Corequisite: PHY 2049.

PHZ 3113 Methods in Theoretical Physics (3). Methods in theoretical physics and theoretical applications in physics. Includes analytic and numerical methods for differential equations, integral equations and transformations and other applications of real analysis. Prerequisite: MAC 2313.

PHZ 3308 Applications of Nuclear Physics (3). An introduction to nuclear structure, radioactivity, nuclear reactions, radiation detection, interactions of radiation with matter, biological effects, and the application of nuclear physics. Prerequisite: PHY 3106.

PHZ 3360 Introduction to Radiation Protection (1). An introduction to the principles of radiation protection. Topics include time, distance, and shielding, activity, radioactive decay, nuclear instrumentation, and the measurement of radiation. Prerequisite: PHY 2049.

PHZ 3361 Radiation Detection and Measurement (3). Interaction of radiation with matter, radiation detectors, gamma spectroscopy, pulse processing, counting statistics, radiation shielding. Prerequisites: PHY 3106 or CHM 3411.

PHZ 3422 Nanoscience and Nanotechnology (3). Introduction to the emerging nanoscience and nanotechnology, physical/chemical understanding of nanomaterials and nanostructures, basic skills and techniques for nanofabrication and characterization. Prerequisite: PHY 2049.

PHZ 4390 Nuclear and Particle Physics (3). Basics of Nuclear and Particle Physics, Nuclear forces, quarkgluon structure of hadrons, deep-inelastic scattering, qcd, nuclear and particle astrophysics, formation of quark-gluon plasma. Prerequisite: PHY 4604.

PHZ 4404 Introduction to Solid State Physics (3). Covers crystal structure, thermal properties, and survey of recent development in condensed matter physics. For upper division physics or engineering majors. Prerequisite: PHY 2049.

PHZ 4710 Introduction to Biophysics (3). Physical investigation of biological molecules with special reference to structure and function of protein, biomembranes and visual receptors. Prerequisites: PHY 3106, PHY 2049, or CHM 3411.

PHZ 4731 Introduction to Health Physics (3). An introduction to health physics. Topics include the biological effects of radiation exposure, environmental and personnel monitoring, dosimetry and dose calculations, and governmental regulations. Prerequisite: PHZ 3361.

PHZ 5130 Theoretical Treatment of Experimental Data (3). Statistical analysis of physical processes and statistical tests, with particular emphasis on instrumentation-related problems. Mathematical modeling and computer simulation. Prerequisites: Undergraduate statistics course or equivalent, or permission of the instructor.

PHZ 5155C Physics Modeling I (4). An inquiry physics-teaching approach incorporating physics education research. Emphasis on basics models in mechanics, scientific discourse, and student learning assessment. May be repeated for credit. Prerequisite: Permission of the instructor.

PHZ 5156 Computational Physics I (3). Physical systems by means of computer simulation. Monte Carlo, molecular dynamics, percolation, random systems, chaos, criticality, gauge fields. Prerequisites: PHY 5115 and PHY 5116.

PHZ 5157C Computational Physics II (3). Advanced computer simulation methods of physical systems. Application in chaos, nonlinear and random systems, criticality, field theory and practices. Prerequisite: PHZ 5156. Corequisites: PHY 5115 and PHY 5116.

PHZ 5234 Atomic and Molecular Collision Phenomena (3). Investigation of atomic and molecular collision phenomena: Kinetic theory, elastic scattering, inelastic scattering, excitation and ionization, heavy particle collisions. Prerequisites: PHY 4605 and PHY 4222. (F or S)

PHZ 5304 Advanced Nuclear Physics (3). Fundamental properties of nuclei, nuclear forces, nuclear models, radioactivity, weak processes and nuclear reactions. Prerequisite: PHY 4604. Corequisite: PHY 4605. (F or S)

PHZ 5340 Particle Interactions and Detection (3). Subatomic particle detectors and the utilization of physics in practical instrumentation applications in medical physics. The course will include laboratory exercises using various detectors. Prerequisites: PHY 3107 or permission of the instructor.

PHZ 5370 Nanoscience (3). Overview of the nanoscience with emphasis on physical properties, such as electrical, magnetic and optical properties, of nanomaterials. Prerequisites: PHY 3106, PHY 3107.

PHZ 5405 Solid State Physics (3). Crystalline form of solids, lattice dynamics, metals, insulators, semiconductors, crystalline surfaces, and amorphous materials. Prerequisites: PHY 3107 or CHM 3411. (F or S)

PHZ 5505 Low Energy Plasma Physics (3). The investigation of the kinetics of rarefied gases and thermal plasmas: Phase space, random currents, orbit theory, plasma sheaths, radiation, the pinch effect. Prerequisites: PHY 3513, PHY 4324, and PHY 4222.

PHZ 5506 Plasma Physics (3). An introduction to plasma fundamentals, the Boltzmann equation, the hydro-dynamic equations, orbit theory, the interaction of electromagnetic waves with plasmas, the pinch effect and instabilities. Prerequisite: PHY 2049.

PHZ 5606 Special Relativity (3). A detailed study of special relativity: Lorentz transformations, relativistic electrodynamics. Prerequisite: PHY 3107.

PHZ 5607 General Relativity (3). General relativity using differential geometry and tensor analysis. Topics include Einstein's field equations and their solutions, applications and observational tests. Black Holes and cosmology are also discussed. Prerequisites: PHY 4222 and PHY 4605.

PHZ 5705 Biomedical Physics (3). Physics principles applied to biology and medicine; transport through cell membranes, biochemical signaling, thermodynamics, neurons, biomechanics, biofluid flow, bioelectrical signals. Prerequisite: PHY 3107.

PHZ 5730 Biophysical Effects of Radiation (3). Biological effects resulting from interactions of radiation and matter for scientifically, technically, and medically oriented students. Prerequisite: PHY 3107.

PHZ 5732 Clinical and Medical Dosimetry (3). Practical patient dosimetry problems in radiation oncology. Irregular field calculations, two-and three-dimensional treatment planning, isodose distribution, dose rate brachytherapy planning. Prerequisite: PHY 3107.

PHZ 5734 Nuclear Medicine Physics (3). The nuclear physics principles of diagnostic and therapeutic applications of radionuclides, radiation beams, with lab activities in facility design, instrumentation essentials, quality assurance. Prerequisite: PHY 3107.

PHZ 5736 Therapeutic Radiological Physics (3). Production, application, and measurement of electromagnetic radiation and particle beams in therapeutic practice. Conceptual, instrumental, and methodological aspects of therapeutic radiology. Prerequisite: PHY 3107.

PHZ 5945 Clinical Experience in Medical Physics (3). Arranged through the Physics Department at local institutions e.g. hospitals, treatment centers, etc., this course places students in clinical medical physics facilities. Prerequisite: PHY 3107.

PSC 3941 Florida Consortium Physical Science Capstone Research Internship (3). Collaborative extramural research course for junior and senior physical science majors. Students are expected to perform research with National Labs, local industry, and partner members of the Florida Consortium. Prerequisites: By permission of the instructor.

PSC 4813 Modeling Instruction (3). Inquiry physics instruction approach incorporating physics education research. Includes basic models in mechanics, scientific discourse, and assessment. Includes use of technology in content delivery. Prerequisite: PHY 3012.

PSC 4814 Advanced Modeling Instruction (3). Extends modeling guided inquiry approach to topics including electricity and magnetism, light, and/or modern physics. Includes use of technology in content delivery. May be repeated for credit. Prerequisite: PSC 4813.