

CHEMISTRY AND PHYSICS

Chair: Sivanadane Mandjiny

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The Chemistry and Physics Department offers a Bachelor of Science degree in Chemistry, a Bachelor of Science degree in Applied Physics, and a Bachelor of Science degree in Biotechnology (in conjunction with the Department of Biology). The Chemistry program is approved by the American Chemical Society and offers specializations within the B.S. degree program in the following areas: (1) Professional, (2) Environmental, (3) Molecular Biotechnology, (4) Pre-Health Professions, (5) Pre-Pharmacy, and (6) Forensic Chemistry. Students completing these programs have been successful at entering professional schools, gaining employment in government and industry, and pursuing graduate studies in chemistry.

The Chemistry and Physics Department also offers a pre-engineering program. This two-year program prepares students for entry into an engineering program at North Carolina A & T State University, North Carolina State University, and the University of North Carolina at Charlotte.

The Department cooperates with the Biology Department in offering required chemistry and physics courses for the B.S. in Science Education.

For students seeking a baccalaureate degree in Elementary Education, Special Education, or Physical Education, the Chemistry and Physics Department offers an Academic Concentration in Physics.

BACHELOR OF SCIENCE IN APPLIED PHYSICS

Requirements for a Bachelor of Science Degree in Applied Physics	Sem. Hrs.
Freshman Seminar	1
General Education Requirements*	44
Major Requirements	
PHY 2000, 2010, 2060, 2070, 2180, 2560, 3000, 3200, 3260, 3560, 4200, 4990	32
CHM 1100, 1110, 1300, 1310	8
CSC 2050	3
MAT 2210, 2220, 3150, 3310, 3320	18
Electives (total elective hours dependent on distribution of General Education courses)	18-32
	Total: 124

BACHELOR OF SCIENCE IN CHEMISTRY

Requirements for a Bachelor of Science Degree in Chemistry	Sem. Hrs.
Freshman Seminar	1
General Education Requirements*	44
Core Major Requirements*	
BIO 1000	3
CHM 1100, 1110, 1300, 1310, 2260, 2270, 2500, 2510, 3980, 4100	30
PHY 1500, 1510, 1560, 1570 or PHY 2000, 2010, 2060, 2070	8
MAT 1070 and 1080 (or equivalent 1090), 2210, 2220	14(12)
**Track Options (see listings below)	34(36)
	Total: 122

*Twelve hours of General Education courses are listed separately above as specific core requirements.

****B.S. in Chemistry Track Option Course Requirements**

Track (Major Code)	Sem. Hrs.
General (CHM)	
CHM 4270	4
Electives (any area)	30 (32)
Analytical (CANL)	
BIOL 1000	1
CHM 3110, 3120, 4270 and six hours of 3990*, 4800* and/or 4990*	14
PHY 2180, 2210, 3560, 4200*, 4210*	15
Electives (any area)	4(6)
*must include department chair and academic advisor-approved analytical chemistry focus	
Environmental (CENV)	
CHM 2300, 3110, 3120, 4270	12
ENV 2100	3
GLY 1150, 2620	6
GLYL 1150	1
Electives	12 (14)
Forensic (CFOR)	
BIOL 1000	1
CHM 3110, 3120, 3210, 3240, 4200, 4270	16
CRJ 2000, 2100, 3000, 3150	12
Electives (any area)	5 (7)
Molecular Biotechnology (CMOL)	
BIO 3150	4
BTEC 3510	3
CHM 3110, 3120, 3210, 3240, 3990 (2 credits)	10
PHY 3410	3
Electives (BTEC 3220, BIO 3710, and CHM 4270 recommended)	14 (16)
Pre-Health Professions (CMED)	
CHM 3110, 3120	4
BIO 1020, 2110, 2120, 3150, 3180, 3710	24
BIOL 1000	1
Electives	5 (7)
Pre-Pharmacy (PHMC)	
BIO 2110, 2120 or 3150 (one of these)	4
BIOL 1000	1
CHM 3110, 3120	4
First year curriculum in approved Pharm. D. program	26
Electives (any area)	0 (1)
Track (Major Code)	Sem. Hrs.
Professional (CHEM)	
CHM 3110, 3120, 3990 (4 credits), 4110, 4260, 4270	20
PHY (<i>the 2000-level sequence noted in the core requirements is required for this track</i>)	
Electives (any area)	14 (16)

BACHELOR OF SCIENCE IN BIOTECHNOLOGY

Requirements for a Bachelor of Science Degree in Biotechnology	Sem. Hrs.
Freshman Seminar	1
General Education Requirements*	44(32)
Biology Core Course Requirements BIOL 1000, BIO 1000, 3150, 3180, 3510, 3710; BTEC 3220, 4900	26
Chemistry and Physics Core Course Requirements CHM 1100, 1110, 1300, 1310, 2270, 2500, 3110, 3120; BTEC 3510; PHY 1500, 1560	27
Elective Courses (Choose 3 of the following) BIO 3200, 3540, or 3810; BTEC 323, 361, BTES 4xxx; CHM 3210, 3240; PHY 1510 and 1570	11-12
Mathematics Course Requirements MAT 2210, 2220	8
Free Electives	14-15
	Total: 120

*Students who plan to major in Biotechnology should consult the program director or coordinator before registering for General Education courses. Twelve hours of General Education courses are listed separately above as specific core requirements.

BACHELOR OF SCIENCE IN SCIENCE EDUCATION (9-12, 6-9)

Coordinator: Mary Ash, Biology Dept.

Upon successful completion of the program of study in Science Education and related requirements, graduates are eligible for a Standard Professional I license to teach in the State of North Carolina. For a more detailed description, including the program standards and goals and objectives, turn to Undergraduate Licensure Programs in the School of Education section of this catalog.

Course Requirements	Sem. Hrs.
Freshman Seminar and General Education	45(33)*
Content Courses —Select one area of concentration (*12 semester hours of Natural Sciences and Mathematics may count toward General Ed)	
Biology (9-12) Concentration: See Biology Dept. for listing of course requirements.	62
Chemistry (9-12) Concentration: See Biology Dept. for listing of course requirements.	62
Earth Science (9-12) Concentration: See Biology Dept. for listing of course requirements.	62
Physics (9-12) Concentration: See Biology Dept. for listing of course requirements.	62
Middle Grades Science (6-9) Concentration: See Biology Dept. for listing of course requirements.	59
Professional Studies Core EDN 2100, 3130, 3140, SED 3310	12
Content Pedagogy SCE 3000, 3010, 3500 or 4000, 4490, 4750; CSC 4050 EDN 3400 (required only for the 6-9 concentration)	21-24
	Total: 128

NOTE: Students who desire teacher licensure in Science Education should declare the major as soon as possible in their college career. Consultation with the Coordinator of Undergraduate Science Education in the Department of Biology prior to registering for General Education courses is strongly recommended.

ACADEMIC CONCENTRATION

For students seeking a baccalaureate degree in Elementary Education, Special Education, or Physical Education, the Department offers an Academic Concentration of 24 hours in Physics. This Academic Concentration is available to other students, regardless of major.

Required Courses for an Academic Concentration in Physics

PHY 1500, 1560, 1510, 1570, 2180, 2560, 3000, 3200, 3260, 4480

Sem. Hrs.

Total: 24

MINOR

Requirements for a Minor in Physics:

A minor in Physics is available to all undergraduates and requires the following: PHY 2000, 2010, 2060, 2070, and 10 additional hours in Physics selected from the course above the 1000 level. The Chemistry and Physics Department has Co-op programs available. For more information, see Chemistry and Physics Department Chair.

PRE-ENGINEERING PROGRAM

Pre-Engineering Program

The Department of Chemistry and Physics is able to offer a pre-engineering program to selected students. Students selected into this program complete two years of a prescribed program at UNC Pembroke. Upon successful completion of this program, these students can transfer into their junior year at one of the engineering schools mentioned below.

Admission to the program is through a formal interview with the Committee on Pre-engineering. Requests for interviews can be made any time with the departmental secretary. Additional information may be obtained from the chair of the Chemistry and Physics Department.

This two-year program prepares students for entry into an engineering program at North Carolina A & T University, North Carolina State University, and the University of North Carolina at Charlotte. However, completion of the UNCP program does not guarantee acceptance into the engineering school at one of these institutions. The student must also satisfy admission requirements for transfer students, and these usually include an acceptable grade point average. Thus, a student should know the admission requirements of the school he or she expects to attend.

Requirements for the Pre-Engineering Program

	Sem. Hrs.
Freshman Seminar	1
General Education Requirements	18
Major Requirements	
CHM 1100, 1110, 1300, 1310	8
PHY 2000, 2010, 2060, 2070	8
MAT 2210, 2220, 3150, 3310, 3320	18
CSC 2050	3
EGR 2000, 2010, 2050	8

Total: 64

COURSES

CHEMISTRY (CHM)

CHM 1100. General Chemistry Laboratory I (1 credit)

Laboratory exercises correlated with topics of Chemistry 1300. PREREQ: Enrollment in or completion of CHM 1300. *Note: Laboratory is required for presentation of General Chemistry as a professional requirement or prerequisite.*

CHM 1110. General Chemistry Laboratory II (1 credit)

Laboratory exercises correlated with topics of Chemistry 1310. PREREQ: CHM 1100 and enrollment in or completion of CHM 1310. *Note: Laboratory is required for presentation of General Chemistry as a professional requirement or prerequisite.*

CHM 1120. Chemistry for Health Sciences Laboratory I (1 credit)

Laboratory exercises correlated with topics of Chemistry 1400. PREREQ: Enrollment in or completion of 1400.

CHM 1130. Chemistry for Health Sciences Laboratory II (1 credit)

Laboratory exercises correlated with topics of Chemistry 1410. PREREQ: CHM 1120 and enrollment in or completion of 1410.

CHM 1300. General Chemistry I (3 credits)

Composition, structure, and properties of matter, including stoichiometry, atomic and molecular structure and theory, chemical periodicity, thermochemistry, and gases. PREREQ: Completion of or enrollment in MAT 1070, 1080, 1090, 1180, 2100, 2110, 2150, 2210, 2220, or 2300.

CHM 1310. General Chemistry II (3 credits)

Chemical reactivity, including properties of solutions, kinetics and equilibrium, acids and bases, and electrochemistry. Basic chemical principles applied to organic, inorganic, and nuclear systems. PREREQ: C- or better in Chemistry 1300.

CHM 1400. Chemistry for Health Sciences I (3 credits)

A broad survey of general chemistry topics relevant to the allied health fields, including composition, structure and properties of matter, equilibrium, and acids and bases. This course is intended for students interested in allied health specializations and may not serve as a prerequisite for upper level chemistry courses.

CHM 1410. Chemistry for Health Sciences II (3 credits)

A broad survey of organic and biochemical topics relevant to the allied health fields, including compound classes, major reactions, and metabolism. This course is intended for students interested in allied health specializations and may not serve as prerequisite for upper level chemistry courses. PREREQ: CHM 1400.

CHM 1990. Introduction to Research in Chemistry (1 credit)

Intended for a student's first research experience, this course involves close faculty supervision and guidance on literature and laboratory work directed towards a common research objective. A detailed laboratory notebook will be maintained and submitted to the supervising faculty member at the conclusion of the course. Pass/Fail grading. PREREQ: Consent of Department Chair.

CHM 2260. Elementary Inorganic Chemistry (4 credits)

Fundamental principles of inorganic chemistry, including coordination and nuclear chemistry, will be examined through a study of the descriptive chemistry of metallic and nonmetallic elements. Laboratories will involve the preparation and characterization of technologically important chemical substances. PREREQ: CHM 1310, 1110.

CHM 2270. Analytical Chemistry (4 credits)

The principles and techniques of classical and simple instrumental methods of chemical analysis will be examined with an emphasis on quality assurance and method validation concepts. Laboratories will involve the use of these analytical techniques in the determination of substances in a variety of sample matrices. PREREQ: CHM 1310, 1110.

CHM 2300. Basic Environmental Chemistry (4 credits)

A study of chemical processes of the earth's lithosphere, hydrosphere and atmosphere, emphasizing environmental issues associated with human activity. Laboratory projects will include the collection, processing, and analysis of soil, water, and air samples. PREREQ: CHM 1310, 1110.

CHM 2500. Organic Chemistry I (4 credits)

The aliphatic and aromatic carbon compounds with special emphasis on structure, major reactions, and reaction mechanisms. A laboratory is included. PREREQ: CHM 1310, 1110.

CHM 2510. Organic Chemistry II (4 credits)

A continuation of CHM 2500. A laboratory is included. PREREQ: CHM 2500.

CHM 3110. Biochemistry (3 credits)

A study of the chemical constitution of living matter and the biochemical build-up and breakdown of molecules in living organisms. PREREQ: One semester of Organic Chemistry.

CHM 3120. Experimental Methods in Biochemistry (1 credit)

A student laboratory that deals with the experimental methods used in biochemistry. PREREQ: Enrollment in, or completion of, CHM 3110.

CHM 3210. Biochemistry II (3 credits)

A continuation and more thorough treatment of biochemical principles considered in CHM 3110. Topics include (1) enzyme mechanisms (2) bioenergetics and metabolism (3) biological membranes (4) regulation of gene expression. PREREQ: CHM 3110.

CHM 3240. DNA Analysis Laboratory (1 credit)

A student laboratory involving experiments focused on the isolation, manipulation, and analysis of DNA from various sources. PREREQ: Enrollment in, or completion of, CHM 3210.

CHM 3520. Organic Chemistry III (3 credits)

A study of organic chemistry emphasizing the major spectroscopic methods, including NMR, IR, UV/Visible, and mass spectrometry, and how data from these sources are used to determine the molecular structure of organic compounds. Laboratory projects are included. PREREQ: Consent of instructor and concurrent registration in either CHM 3990 or CHM 4990 for 1-3 semester hours.

CHM 3980. Scientific Literature (2 credits)

Introduction to methodology of researching topics in the chemical literature and to the writing conventions used in the chemical literature. PREREQ: CHM 2500.

CHM 3990. Research in Chemistry (1-3 credits, repeatable for up to 6 credits)

This course involves student research on projects supervised by departmental faculty. Both laboratory and literature research are typically included, and a detailed lab notebook and formal report of results will be submitted to the supervising faculty member at the conclusion of the course. Pass/Fail grading. PREREQ: Completion of or enrollment in at least one 2000-level chemistry lab course and consent of Department Chair.

CHM 4100. Physical Chemistry I (4 credits)

A theoretical and mathematical treatment of the fundamental laws and theories underlying the science of chemistry. Included is a student laboratory that deals with experimental methods used in physical chemistry. PREREQ: MAT 2210 and 2220, either PHY 1500 or PHY 2000, and at least 16 hours of CHM coursework at or above the 2000 level and CHM 3980.

CHM 4110. Physical Chemistry II (4 credits)

A continuation of CHM 4100. Included is a student laboratory that deals with experimental methods used in physical chemistry. PREREQ: CHM 4100.

CHM 4200. Forensic Chemistry (4 credits)

An examination of chemical theories and practices related to the analysis of physical evidence in criminal investigations. Included laboratory work will emphasize the use of analytical instrumentation commonly encountered in modern crime labs. PREREQ: CHM 2270 and 3110.

CHM 4260. Advanced Inorganic Chemistry (4 credits)

The bonding, structure, and reactions of inorganic substances will be explored through applications of appropriate physico-chemical theories. Laboratory projects are included which employ a variety of instrumental methods to examine thermodynamic and kinetic properties of inorganic systems. PREREQ: CHM 2260, CHM 4100.

CHM 4270. Instrumental Analysis (4 credits)

Advanced topics related to instrumental methods of chemical analysis will be examined. Laboratory projects will focus on the finer points of data acquisition, analysis, and evaluation. PREREQ: CHM 2270, CHM 4100; PHY 1510/1570 or PHY 2010/2070.

CHM 4800. Internship in Chemistry (1-4 credits)

Experiential learning through work with an external agency. Internships are arranged on an individual basis and must involve chemistry-related work and supervision by both the agency's staff and a University faculty member. An internship application must be approved by the Department Chair prior to registration. Academic credit will be awarded at a maximum rate of 1 semester hour for each 40 clock hours of work with the agency. Pass/Fail grading. PREREQ: 24 semester hours of CHM course work and consent of the Department Chair.

CHM 4990. Independent Study in Chemistry (1-3 credits)

Individual study in advanced areas of chemistry. Offered for chemistry majors only. PREREQ: Consent of Department Chair.

CHMS 44xx. Special Topics in Chemistry (1-3 credits)

Advanced class study in selected areas of chemistry. PREREQ: Consent of the Instructor.

CHMS 49xx. Seminar (1 credit, repeatable up to 4 credits)

A seminar series in which current research projects are presented and discussed. Most seminars will be presented by visiting scientists recruited from research laboratories in industry and universities. PREREQ: Consent of instructor.

BIOTECHNOLOGY (BTEC)**BTEC 3220. Biotechnology I (4 credits)**

See listing in Department of Biology. PREREQ: BIO 1000, 3180.

BTEC 3230. Biotechnology II (4 credits)

See listing in Department of Biology. PREREQ: BIO 1000, BTEC 3220.

BTEC 3510. Bioprocessing (3 credits)

A laboratory intensive course designed to train students in selected aspects of fermentation for the production of biochemicals and macromolecules. Students will learn theory and practical application for important techniques in projects related to fermentation and bioconversion. PREREQ: BIO 3150 or BIO 3710 and CHM 3110.

BTEC 3610. Bioseparations Technology (3 credits)

A laboratory intensive course designed to train students in selected aspects of the separation and downstream processing of biomolecules. The specific objectives include the application of: (1) product recovery methods, (2) product purification technology to biomanufacturing. The technologies will be explored in view of bench scale, pilot and commercial scale processes. PREREQ: CHM 2510

BTEC 4300. Principles of Medical Biotechnology (3 credits)

See listing in Department of Biology. PREREQ: BIO 1000, CHM 1310.

BTEC 4900. Internship/Co-op (3 credits)

See listing in Department of Biology. PREREQ: Consent of the Biotechnology Program Director or Coordinator.

BTES 4xxx. Special Topics in Biotechnology (3 credits)

See listing in Department of Biology. PREREQ: Consent of the instructor.

ENGINEERING (EGR)**EGR 2000. Engineering Statics (3 credits)**

The study of engineering statics using vector calculus. Basic concepts, forces, and equilibrium analysis, distributed forces, centroids, moments of inertia, virtual work, applications to machines, structures, and systems. PREREQ OR COREQ: PHY 2000, MAT 2210.

EGR 2010. Engineering Dynamics (3 credits)

The study of engineering dynamics using vector calculus. Equations of motion, kinematics, kinetics of mass points and systems of mass points, kinetics, and kinematics of rigid bodies. PREREQ: EGR 2000.

EGR 2050. Engineering Graphics (2 credits)

Introduction to graphical representation and engineering drawing. Instrument and freehand drawing of structures and machine parts, including isometric, oblique, and perspective drawings, sectional and auxiliary views, and orthographic projections. (Laboratory)

PHYSICAL SCIENCE (PHS)**PHS 1080, 1090. Physical Science Laboratory I and II (1 credit each)**

Laboratory activities designed to parallel and reinforce the concepts presented in PHS 1100 and 1110. PREREQ: Enrollment in or completion of PHS 1100 or equivalent.

PHS 1100, 1110. Physical Science I and II (3 credits each)

Intended for the non-science major, these courses serve as an introduction to fundamental concepts in chemistry and physics. PREREQ: None for PHS 1100; PHS 1100 or equivalent for PHS 1110.

PHS 1140. Physics of Music (3 credits)

This course examines the creation, characteristics, hearing, and reproduction of sound in general and of music specifically. Students will also design, construct, and demonstrate their own instruments.

PHS 1160. Exploring Man's Energy Choices (3 credits)

A survey of the evolution of the energy crisis. The various energy alternatives are considered with regard to the technological, environmental, and economic problems associated with each.

PHS 1560. Astronomy (3 credits)

A study of all matter and energy in the universe, emphasizing the concentration of this matter and energy in evolving bodies such as planets, stars, and galaxies. Topics include the sun, solar systems, stars, black holes, pulsars, supernova and quasars.

PHS 1570. Astronomy Laboratory (1 credit)

Astronomical observations and principles of experimentation, includes knowledge of the sky and its motions, optics, star and galaxy properties both with real physical experiments and computer simulations. Hands-on laboratory, usually held in the evenings so the heavens can be observed on clear nights. This course is often taken simultaneously with Astronomy 1560. PREREQ: enrollment in or completion of PHS 1560.

PHS 2460. Weather and Climate (GGY 2460, GLY 2460) (3 credits)

Study of atmospheric elements and controls, weather analysis and forecasting, and air pollution issues. Also includes a survey of world climate regions and applications of climate data.

PHYSICS (PHY)**PHY 1000. Elementary Physics I (3 credits)**

In an essentially descriptive fashion this course describes the nature of: motion and its causes, energy, momentum, theory of relativity, heat and temperature, pressure, sound, and others.

PHY 1010. Elementary Physics II (3 credits)

In the fashion of PHY 1010, this course describes the nature of electricity and magnetism, light and optical devices, and the atom (what we now know and what we believe we can't know). PREREQ: It is helpful (but not required) to have taken PHY 1000 as background for this course.

PHY 1200. Science and Computing (2 credits)

A broad survey of topics related to the role computers play in science. No special knowledge is required of the student as the course is meant as an introduction to anyone interested in how computers are used in the field of science. Topics will include design and function of the PC, data collection and analysis, the Internet, Fortran programming, and basic word processing.

PHY 1500, 1510. College Physics I, II (3 credits each)

A treatment of the subject matter of general physics (listed, in part, under 1000, 1010) at a level of thoroughness expected in such curricula as pre-med, biochemistry, etc. (for pre-engineering or physics curricula see PHY 2000, 2010). PREREQ: for PHY 1500, MAT 10701090, 2210, or 2220; for PHY 1510, completion of PHY 1500.

PHY 1560, 1570. College Physics Lab I, II (1 credit each)

A student laboratory to complement and reinforce the physical relationships discussed in the lecture classes. PREREQ: for PHY 1560, enrollment in or completion of PHY 1000 or 1500; for PHY 1570, enrollment in or completion of PHY 1010 or 1510.

PHY 2000. University Physics I (3 credits)

A study of Classical Newtonian mechanics with an emphasis on Newton's three laws of motion. This calculus-based course describes the nature of motion, forces, energy, momentum, collisions, rotation, gravitation, sound, and heat. A beginning course expected in such curricula as pre-engineering, physics, etc. PREREQ OR COREQ: MAT 2210.

PHY 2010. University Physics II (3 credits)

A calculus-based study of electricity, magnetism, optics, relativity, quantum and nuclear physics. A beginning course expected in such curricula as pre-engineering, physics, etc. PREREQ: PHY 2000.

PHY 2060. University Physics Laboratory I (1 credit)

A student laboratory to complement and reinforce the physical relationships discussed in the University Physics lecture classes. PREREQ: Enrollment in or completion of PHY 2000.

PHY 2070. University Physics Laboratory II (1 credit)

A student laboratory to complement and reinforce the physical relationships discussed in the University Physics lecture classes. PREREQ: Enrollment in or completion of PHY 2010.

PHY 2180. Optics (3 credits)

Optical instruments such as cameras, telescopes, and many more are discussed. Their uses, limitations, and how they work are all included. Experimentation comprises half of the course. PREREQ: PHY 1010, 1510, or 2010.

PHY 2210. Hardware and Software Concepts (3 credits)

Introductory class exploring the role of computers in contemporary physics. Topics of discussion include hardware architecture, basic concepts in programming, and the application of existing software to classical problems. PREREQ: CSC 2050, PHY 2000.

PHY 2560. Modern Physics (4 credits)

A survey of 20th century physics including the fundamental ideas underlying special relativity and quantum mechanics. Includes a mandatory three-hour weekly laboratory. PREREQ: PHY 1010, 1510, or 2010.

PHY 2600. Astrophysics (3 credits)

An introduction to a range of astrophysical topics with an emphasis on the physical processes involved. Examples of such topics are the discovery of planets and the possibility of life around other stars, stellar formation and structure, supernovae, galactic dynamics and dark matter, theory of relativity and black holes, cosmology, and dark energy. PREREQ: PHS 1560, PHY 2000.

PHY 2880. Methods of Computational Science (3 credits)

An overview of the methods common to computational science. Topics to include numerical differentiation and integration, Monte Carlo techniques, and how to use higher level programs, e.g. Maple, Mathematica, or Gaussian. Students will also be introduced to computing on a supercomputer with projects to be completed via the North Carolina Super Computer Center (NCSC). PREREQ: PHY 2210.

PHY 3000. Classical Mechanics (3 credits)

Mechanics of particles and system of particles. Solution of problems in Newtonian Mechanics, one dimensional motion, linear, damped, and driven oscillations; two particle collisions, introduction to Lagrangian and Hamiltonian Dynamics. Central force motion. PREREQ: PHY 1500 or 2000 and a working knowledge of calculus.

PHY 3200, 3210. Electricity and Magnetism (3 credits each)

Electrostatics, magnetic and electric fields, capacitance, inductance, electric machinery and meters. PREREQ: PHY 1010, 1510, or 2010 and working knowledge of calculus for PHY 3200; PHY 3200 for 3210.

PHY 3260. Heat and Temperature (3 credits)

Heat and its effects; heat engines and their limitations. The concepts of entropy and other facets of thermodynamics. PREREQ: PHY 1000, 1500, or 2000 and a working knowledge of calculus.

PHY 3360. Mathematical Physics (3 credits)

Three dimensional vector and tensor calculus. Green's and Stoke's theorems. Vector spaces, linear independence, orthogonality. Hermitian and unitary operators. Eigenvalues and eigenvectors of operators, functions spaces as vector spaces, and elements of the theory of distributions. PREREQ: A working knowledge of calculus.

PHY 3410. Biophysics (3 credits)

Physics applied to biological phenomena, particularly from the point of view of molecular systems and processes. PREREQ: Two semesters of physics, a semester of biology and organic chemistry.

PHY 3560. Modern Electronics (3 credits)

An introduction to Analog and Digital Electronics. Problems and techniques of interfacing with laboratory instruments and computers. PREREQ: PHY 1150 or 1510 or 2010 or equivalent.

PHY 3880. Advanced Computational Physics (3 credits)

A project driven course in which the student will use various computational approaches to solve standard and/or modern problems in physics. Techniques will include C++ programming, Fortran programming, and advanced applications of software packages such as Maple, Mathematica, or Gaussian. PREREQ: PHY 2880.

PHY 3900. Computational Research in Physics (3 credits)

Requirements for this course include the completion of one or more computationally oriented research projects. Topics will be chosen from current interest across the broad spectrum of contemporary physics. PREREQ: PHY 3880.

PHY 4000. Quantum Mechanics (3 credits)

Generalized eigenvalue problems, angular momentum, spin, the hydrogen atom, and perturbation theory with selected applications from atomic, solid state, and nuclear physics. PREREQ: PHY 2560 and a working knowledge of calculus.

PHY 4200/4210. Advanced Laboratory I & II (3 credits)

Modern physics experiments available from several areas. Choices include: atomic physics, NMR, nuclear physics, radio astronomy, optics and spectroscopy. PREREQ: Consent of Instructor.

PHY 4990. Independent Study (1-3 credits)

Independent study with departmental faculty member. PREREQ: Consent of Department Chair and Instructor.

PHYS 4xxx. Special Topics (1-3 credits)

Individual study either of subject matter in existing courses (in more depth) or of subjects for which there is no present formal course. PREREQ: PHY 1010, 1510, or 2010; MAT 2220.