

**CHEMISTRY AND PHYSICS**

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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 and the B.S. in Biology Education. The Department also cooperates with the Education Department in offering a science concentration of the B.S. in Middle Grades Education (6-9).

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 200, 201, 206, 207, 218, 256, 300, 320, 326, 356, 420, 499	32
CHM 110, 111, 130, 131	8
CSC 205	3
MAT 221, 222, 315, 331, 332	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 100	3
CHM 110, 111, 130, 131, 226, 227, 250, 251, 298, 410	29
PHY 150, 151, 156, 157 or PHY 200, 201, 206, 207	8
MAT 107 and 108 (or equivalent 109), 221, 222	14(12)
**Track Options (see listings below)	35(37)
<b>Total:</b>	<b>122</b>

\*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.
<b>General (CHM)</b>	
CHM 427	4
Electives (any area)	31 (33)
<b>Environmental (CENV)</b>	
CHM 230, 311, 312, 427	12
ENV 210	3
GLY 115, 262	6
GLYL 115	1
Electives	13 (15)
<b>Forensic (CFOR)</b>	
BIOL 100	1
CHM 311, 312, 321, 324, 420, 427	16
CRJ 200, 210, 300, 315	12
Electives (any area)	6 (8)
<b>Molecular Biotechnology (CMOL)</b>	
BIO 315	4
CHM 311, 312, 321, 331, 351, 399 (2 credits)	16
PHY 341	3
Electives (BIO 322, 371, and CHM 427 recommended)	12 (14)
<b>Pre-Health Professions (CMED)</b>	
CHM 311, 312	4
BIO 102, 211, 212, 315, 371, 427	24
BIOL 100	1
Electives	6 (8)
<b>Pre-Pharmacy (PHMC)</b>	
BIO 211, 212 or 315 (one of these)	4
BIOL 100	1
CHM 311, 312	4
First year curriculum in approved Pharm. D. program	26
Electives (any area)	0 (2)
<b>Professional (CHEM)</b>	
CHM 311, 312, 399 (4 credits), 411, 426, 427	20
PHY ( <i>the 200-level sequence noted in the core requirements is required for this track</i> )	
Electives (any area)	15 (17)

## 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	26
BIO 100, 100L, 315, 323, 351, 371, 472, 490	
Chemistry and Physics Core Course Requirements	27
CHM 110, 111, 130, 131, 227, 250, 311, 312, 351; PHY 150, 156	
Elective Courses (Choose 3 of the following)	11-12
BIO 320, 354, or 381; CHM 331; PHY 151 and 157	
Mathematics Course Requirements	8
MAT 221, 222	
Free Electives	14-15
<b>Total:</b>	<b>120</b>

\*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)

Coordinator: Rachel McBroom, Biology Dept.

Upon successful completion of the program of study in Science Education and related requirements, graduates are eligible for an "A" 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.
<b>Freshman Seminar and General Education</b>	<b>45(33)*</b>
<b>Specialty Area</b> —Select one area of concentration (*12 semester hours of Natural Sciences and Mathematics may count toward General Ed)	
<b>Biology Concentration:</b>	<b>62</b>
See Biology Dept. for listing of course requirements.	
<b>Chemistry Concentration:</b>	<b>62</b>
See Biology Dept. for listing of course requirements.	
<b>Earth Science Concentration:</b>	<b>62</b>
See Biology Dept. for listing of course requirements.	
<b>Physics Concentration:</b>	<b>62</b>
See Biology Dept. for listing of course requirements.	
<b>Professional Studies</b>	<b>15</b>
EDN 302, 312, 350, 419, SED 300	
<b>Content Pedagogy</b>	<b>18</b>
SCE 300, 301, 400	
CSC 405	
SCE 449	
<b>Biology, Chemistry, Earth Science, or Physics Concentration Total:</b>	<b>128</b>

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.

## LICENSURE IN SCIENCE FOR MIDDLE GRADES EDUCATION (6-9)

Students majoring in Middle Grades Education (6-9) are required to complete two teaching specialty areas. For a detailed description of the program of study in Middle Grades Education, including the program standards and goals and objectives, turn to Undergraduate Licensure Programs in the School of Education section of this catalog.

Students majoring in Middle Grades Education (6-9) with a Science teaching specialty area should consult with the Coordinator of Undergraduate Science Education in the Department of Biology and the Middle Grades Program Coordinator in the School of Education. 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.

<b>Requirements for Licensure in Science for a B.S. in Middle Grades Education (6-9)</b>	<b>Sem. Hrs.</b>
PHS 110, 108, 109; BIO 100, 100L, 103, 304; GLY 115, 115L, 125, 125L; SCE 300, 301, 350	
	<b>Total: <del>24</del>30</b>

## ACADEMIC CONCENTRATIONS

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.

<b>Required Courses for an Academic Concentration in Physics</b>	<b>Sem. Hrs.</b>
PHY 150, 156, 151, 157, 218, 256, 300, 320, 326, 448	
	<b>Total: 24</b>

## MINOR

### Requirements for a Minor in Physics:

A minor in Physics is available to all undergraduates and requires the following: PHY 200, 201, 206, 207, and 10 additional hours in Physics selected from the course above the 100 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 110, 111, 130, 131	8
PHY 200, 201, 206, 207	8
MAT 221, 222, 331, 332	15
CSC 155, 205	6
EGR 200, 201, 205	8
	<b>Total: 64</b>

## COURSES

### CHEMISTRY (CHM)

#### CHM 110. General Chemistry Laboratory I

Laboratory exercises correlated with topics of Chemistry 130. Fall, Spring. Credit, 1 semester hour. PREREQ: Enrollment in or completion of CHM 130. *Note: Laboratory is required for presentation of General Chemistry as a professional requirement or prerequisite.*

#### CHM 111. General Chemistry Laboratory II

Laboratory exercises correlated with topics of Chemistry 131. Fall, Spring. Credit, 1 semester hour. PREREQ: CHM 110 and enrollment in or completion of CHM 131. *Note: Laboratory is required for presentation of General Chemistry as a professional requirement or prerequisite.*

#### CHM 112. Chemistry for Health Sciences Laboratory I

Laboratory exercises correlated with topics of Chemistry 140. Fall. Credit, 1 semester hour. PREREQ: Enrollment in or completion of 140.

#### CHM 113. Chemistry for Health Sciences Laboratory II

Laboratory exercises correlated with topics of Chemistry 141. Spring. Credit, 1 semester hour. PREREQ: CHM 112 and enrollment in or completion of 141.

#### CHM 130. General Chemistry I

Composition, structure, and properties of matter, including stoichiometry, atomic and molecular structure and theory, chemical periodicity, and equilibrium. Fall, Spring. Credit, 3 semester hours.

#### CHM 131. General Chemistry II

Chemical reactivity, including properties of solutions, kinetics and equilibrium, acids and bases, and electrochemistry. Basic chemical principles applied to organic, inorganic, and nuclear systems. Fall, Spring. Credit, 3 semester hours. PREREQ: Chemistry 130.

#### CHM 140. Chemistry for Health Sciences I

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. Fall. Credit, 3 semester hours.

#### CHM 141. Chemistry for Health Sciences II

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. Spring. Credit, 3 semester hours. PREREQ: CHM 140.

**CHM 226. Elementary Inorganic Chemistry**

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. Fall/Spring. Credit, 4 semester hours. PREREQ: CHM 131, 111.

**CHM 227. Analytical Chemistry**

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. Fall. Credit, 4 semester hours. PREREQ: CHM 131, 111.

**CHM 230. Basic Environmental Chemistry**

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. As announced. Credit, 4 semester hours. PREREQ: CHM 131, 111.

**CHM 250. Organic Chemistry I**

The aliphatic and aromatic carbon compounds with special emphasis on structure, major reactions, and reaction mechanisms. A laboratory is included. Fall, Spring. Credit, 4 semester hours. PREREQ: CHM 131, 111.

**CHM 251. Organic Chemistry II**

A continuation of CHM 250. A laboratory is included. Fall, Spring. Credit, 4 semester hours. PREREQ: CHM 250.

**CHM 298. Scientific Literature**

Introduction to methodology of researching topics in the chemical literature. Fall, Spring. Credit, 1 semester hour. PREREQ: CHM 250.

**CHM 311. Biochemistry**

A study of the chemical constitution of living matter and the biochemical build-up and breakdown of molecules in living organisms. As announced. Credit, 3 semester hours. PREREQ: One semester of Organic Chemistry.

**CHM 312. Experimental Methods in Biochemistry**

A student laboratory that deals with the experimental methods used in biochemistry. As announced. Credit, 1 semester hour. PREREQ: Enrollment in, or completion of, CHM 311.

**CHM 321. Biochemistry II**

A continuation and more thorough treatment of biochemical principles considered in CHM 311. Topics include (1) enzyme mechanisms (2) bioenergetics and metabolism (3) biological membranes (4) regulation of gene expression. As announced. Credit, 3 semester hours. PREREQ: CHM 311.

**CHM 324. DNA Analysis Laboratory**

A student laboratory involving experiments focused on the isolation, manipulation, and analysis of DNA from various sources. As announced. Credit, 1 semester hour. PREREQ: Enrollment in, or completion of, CHM 321.

**CHM 331. Bioanalytical Chemistry**

A laboratory intensive course examining fundamental and practical aspects of analytical methods for the separation and analysis of biological compounds and macromolecules. As announced. Credit, 4 semester hours. PREREQ: CHM 227.

**CHM 351. Bioprocessing**

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. As announced. Credit, 3 semester hours. PREREQ: BIO 315 or BIO 371 and CHM 311.

**CHM 352. Organic Chemistry III**

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. As announced. Credit, 3 semester hours. PREREQ: Consent of instructor and concurrent registration in either CHM 399 or CHM 499 for 1-3 semester hours.

**CHM 361. Bioseparations Technology**

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. As announced. Credit, 3 semester hours. PREREQ: CHM 251

**CHM 399. Research in Chemistry**

This course involves student research on projects supervised by departmental faculty. Both laboratory and library work are typically included, and a formal report of results is required upon completion of the project. Fall, Spring. Pass/Fail grading. Credit, 1-3 semester hours. May be repeated for a maximum of 6 semester hours. PREREQ: Consent of Department Chair.

**CHM 410. Physical Chemistry I**

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. As announced. Credit, 4 semester hours. PREREQ: MAT 221 and 222, either PHY 150 or PHY 200, and at least 16 hours of CHM coursework at or above the 200 level.

**CHM 411. Physical Chemistry II**

A continuation of CHM 410. Included is a student laboratory that deals with experimental methods used in physical chemistry. As announced. Credit, 4 semester hours. PREREQ: CHM 410.

**CHM 420. Forensic Chemistry**

An examination of chemical theories and practices related to the analysis of physical evidence in criminal investigations. Three one-hour lectures and one three-hour laboratory meeting weekly. As announced. Credit, 4 semester hours. PREREQ: CHM 227 and 311.

**CHM 426. Advanced Inorganic Chemistry**

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. As announced. 4 semester hours. PREREQ: CHM 226, CHM 410.

**CHM 427. Instrumental Analysis**

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. Spring. Credit, 4 semester hours. PREREQ: CHM 227, CHM 410; PHY 151/157 or PHY 201/207.

**CHM 480. Internship in Chemistry**

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. Fall, Spring, Summer. Pass/Fail grading. Credit, 1-4 semester hours. PREREQ: 24 semester hours of CHM course work and consent of the Department Chair.

### **CHM 499. Independent Study in Chemistry**

Individual study in advanced areas of chemistry. Offered for chemistry majors only. Fall, Spring. Credit, 1 to 3 semester hours. PREREQ: Consent of Department Chair.

### **CHMS 44x. Special Topics in Chemistry**

Advanced class study in selected areas of chemistry. As announced. Credit, 1-3 semester hours. PREREQ: Consent of the Instructor.

### **CHMS 49x. Seminar**

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. Fall/Spring. Credit, 1 hour per semester; may be repeated for up to 4 semester hours. PREREQ: Consent of instructor.

## **ENGINEERING (EGR)**

### **EGR 200. Engineering Statics**

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. An announced. Credit, 3 semester hours. PREREQ OR COREQ: PHY 200, MAT 221.

### **EGR 201. Engineering Dynamics**

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. As announced. Credit, 3 semester hours. PREREQ: EGR 200.

### **EGR 205. Engineering Graphics**

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) Fall/Spring. Credit, 2 semester hrs.

## **PHYSICAL SCIENCE (PHS)**

### **PHS 108, 109. Physical Science Laboratory I and II**

Laboratory activities designed to parallel and reinforce the concepts presented in PHS 110 and 111. Fall/Spring. Credit. 1 semester hour each. PREREQ: Enrollment in or completion of PHS 110 or equivalent.

### **PHS 110, 111. Physical Science I and II**

Intended for the non-science major, these courses serve as an introduction to fundamental concepts in chemistry and physics. Fall/Spring. Credit. 3 semester hours each. PREREQ: None for PHS 110; PHS 110 or equivalent for PHS 111.

### **PHS 116. Exploring Man's Energy Choices**

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. Fall. Credit, 3 semester hours.

### **PHS 156. Astronomy**

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. Fall, Spring. Credit, 3 semester hours.

**PHS 157. Astronomy Laboratory**

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 156. Fall, Spring. Credit, 1 semester hour. PREREQ: enrollment in or completion of PHS 156.

**PHS 246. Weather and Climate (GGY 246, GLY 246)**

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. Fall and Spring. Credit, 3 semester hours.

**PHYSICS (PHY)****PHY 100. Elementary Physics I**

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. As announced. Credit, 3 semester hours.

**PHY 101. Elementary Physics II**

In the fashion of PHY 101, 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). As announced. Credit, 3 semester hours. PREREQ: It is helpful (but not required) to have taken PHY 100 as background for this course.

**PHY 120. Science and Computing**

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. As announced. Credit, 2 semester hours.

**PHY 150, 151. College Physics I, II**

A treatment of the subject matter of general physics (listed, in part, under 100, 101) at a level of thoroughness expected in such curricula as pre-med, biochemistry, etc. (for pre-engineering or physics curricula see PHY 200, 201). Fall, Spring. Credit, 3 semester hours each. PREREQ: for PHY 150, MAT 107 or equivalent; for PHY 151, completion of PHY 150.

**PHY 156, 157. College Physics Lab I, II**

A student laboratory to complement and reinforce the physical relationships discussed in the lecture classes. Fall, Spring. Credit, 1 semester hr. each. PREREQ: for PHY 156, enrollment in or completion of PHY 100 or 150; for PHY 157, enrollment in or completion of PHY 101 or 151.

**PHY 200. University Physics I**

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. As announced. Credit, 3 semester hours. PREREQ OR COREQ: MAT 221.

**PHY 201. University Physics II**

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. As announced. Credit, 3 semester hours. PREREQ: PHY 200.

**PHY 206. University Physics Laboratory I**

A student laboratory to complement and reinforce the physical relationships discussed in the Univer-

sity Physics lecture classes. Fall, Spring. Credit, 1 semester hour each. PREREQ: Enrollment in or completion of PHY 200.

### **PHY 207. University Physics Laboratory II**

A student laboratory to complement and reinforce the physical relationships discussed in the University Physics lecture classes. Fall, Spring. Credit, 1 semester hour each. PREREQ: Enrollment in or completion of PHY 201.

### **PHY 218. Optics**

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. As announced. Credit, 3 semester hours. PREREQ: PHY 101, 151, or 201.

### **PHY 221. Hardware and Software Concepts**

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. As announced. Credit, 3 semester hours. PREREQ: CSC 205, PHY 200.

### **PHY 256. Modern Physics**

A survey of the physics of the 20th century. The fundamental ideas of the theory of relativity and quantum mechanics via the anomalies that led to their formulation. As announced. Credit, 3 semester hours. PREREQ: PHY 101, 151, or 201.

### **PHY 288. Methods of Computational Science**

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). As announced. Credit, 3 semester hours. PREREQ: PHY 221.

### **PHY 300. Classical Mechanics**

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. As announced. Credit, 3 semester hours. PREREQ: PHY 150 or 200 and a working knowledge of calculus.

### **PHY 320, 321. Electricity and Magnetism**

Electrostatics, magnetic and electric fields, capacitance, inductance, electric machinery and meters. As announced. Credit, 3 semester hours each. PREREQ: PHY 101, 151, or 201 and working knowledge of calculus for PHY 320; PHY 320 for 321.

### **PHY 326. Heat and Temperature**

Heat and its effects; heat engines and their limitations. The concepts of entropy and other facets of thermodynamics. As announced. Credit, 3 semester hours. PREREQ: PHY 100, 150, or 200 and a working knowledge of calculus.

### **PHY 336. Mathematical Physics**

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. As announced. Credit, 3 semester hours. PREREQ: A working knowledge of calculus.

### **PHY 341. Biophysics**

Physics applied to biological phenomena, particularly from the point of view of molecular systems and processes. As announced. Credit, 3 semester hours. PREREQ: Two semesters of physics, a semester of biology and organic chemistry.

**PHY 356. Modern Electronics**

An introduction to Analog and Digital Electronics. Problems and techniques of interfacing with laboratory instruments and computers. Spring. Credit, 3 semester hours. PREREQ: PHY 115 or 151 or 201 or equivalent.

**PHY 388. Advanced Computational Physics**

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. As announced. Credit, 3 semester hours. PREREQ: PHY 288.

**PHY 390. Computational Research in Physics**

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. As announced. Credit, 3 semester hours. PREREQ: PHY 388.

**PHY 400. Quantum Mechanics**

Generalized eigenvalue problems, angular momentum, spin, the hydrogen atom, and perturbation theory with selected applications from atomic, solid state, and nuclear physics. As announced. Credit, 3 semester hours. PREREQ: PHY 256 and a working knowledge of calculus.

**PHY 420/421. Advanced Laboratory I & II**

Modern physics experiments available from several areas. Choices include: atomic physics, NMR, nuclear physics, radio astronomy, optics and spectroscopy. As announced. Credit, 3 semester hours. PREREQ: Consent of Instructor.

**PHY 499. Independent Study**

Independent study with departmental faculty member. As announced. Credit, 1-3 semester hours. PREREQ: Consent of Department Chair and Instructor.

**PHYS 4xx. Special Topics**

Individual study either of subject matter in existing courses (in more depth) or of subjects for which there is no present formal course. As announced. Credit, 1-3 semester hours. PREREQ: PHY 101, 151, or 201; MAT 222.