APPLIED AND ENGINEERING SCIENCES

Applied and Engineering Sciences

The four-year Bachelor of Science degree program in Applied and Engineering Science (A&ES) blends a core of engineering preparation with flexibility for students to focus on areas of specific interest. It is ideal for students with specific engineering interests outside the configuration of traditional engineering programs. Successful examples include medicine, performing arts engineering (sound, lighting, staging, recording), computer science, safety and reliability, information technology, and patent law. To this end, faculty and facilities center on the individual, incorporating the adoption of new technological developments with an emphasis on analysis, design, and application, on student-faculty-industry cooperative projects, on the concept of teamwork, and on the hands-on student utilization of modern laboratories and computer systems. Wilkes University does not maintain professional accreditation for the A&ES program.

The A&ES program demands careful planning by the student with his or her faculty advisor to assure a clear and well-planned program configured realistically to the students’ interests and needs.

Applied and Engineering Sciences
Major - Required Courses and Recommended Course Sequence

First Semester

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>[MTH-111] Calculus I</td>
<td>4</td>
</tr>
<tr>
<td>[CHM-117] Intro Chem Lab for Engineers</td>
<td>1</td>
</tr>
<tr>
<td>[CHM-118] Chemistry for Engineers</td>
<td>3</td>
</tr>
<tr>
<td>[ME-180] CADD Lab</td>
<td>1</td>
</tr>
<tr>
<td>[ENG-101] Composition</td>
<td>4</td>
</tr>
<tr>
<td>[FYF-101] First-Year Foundations</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>16</td>
</tr>
</tbody>
</table>

Second Semester

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>[MTH-112] Calculus II</td>
<td>4</td>
</tr>
<tr>
<td>[PHY-201] General Physics I</td>
<td>4</td>
</tr>
<tr>
<td>[ME-140] Scientific Programming</td>
<td>3</td>
</tr>
<tr>
<td>Distribution Requirement</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>17</td>
</tr>
</tbody>
</table>

Third Semester

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>[PHY-202] General Physics II</td>
<td>4</td>
</tr>
<tr>
<td>Free Elective</td>
<td>3</td>
</tr>
<tr>
<td>Distribution Requirement</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>13</td>
</tr>
</tbody>
</table>

Fourth Semester

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>[EGR-200] Intro to Materials Science</td>
<td>3</td>
</tr>
<tr>
<td>Free Electives</td>
<td>9</td>
</tr>
<tr>
<td>Distribution Requirements</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>15</td>
</tr>
</tbody>
</table>

Fifth Semester

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>[EE-283] Electrical Measurement Lab</td>
<td>1</td>
</tr>
<tr>
<td>[ME-231] Statics</td>
<td>3</td>
</tr>
<tr>
<td>[EE-211] Electrical Circuits &amp; Devices</td>
<td>3</td>
</tr>
<tr>
<td>Free Electives</td>
<td>6</td>
</tr>
<tr>
<td>Distribution Requirement</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>16</td>
</tr>
</tbody>
</table>

Sixth Semester

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>[EGR-399] Cooperative Education or Technical Electives</td>
<td>6</td>
</tr>
<tr>
<td>Technical Elective</td>
<td>3</td>
</tr>
<tr>
<td>[EGR-201] Professionalism and Ethics</td>
<td>1</td>
</tr>
<tr>
<td>[EGM-320] Engineering Project Management &amp; Analysis</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>13</td>
</tr>
</tbody>
</table>

Seventh Semester

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>[EGR-391] Senior Project I*</td>
<td>1</td>
</tr>
<tr>
<td>Technical Electives**</td>
<td>6</td>
</tr>
<tr>
<td>Free Elective</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>16</td>
</tr>
</tbody>
</table>

Eighth Semester

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>[EGR-392] Senior Projects II*</td>
<td>2</td>
</tr>
<tr>
<td>Electives</td>
<td>6</td>
</tr>
<tr>
<td>Technical Electives</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>14</td>
</tr>
</tbody>
</table>

* [EGR-391] and [EGR-392] may be replaced by EE/EGM/ENV/ME 391 and 392, depending on the student's concentration.

**Technical Electives may be selected from advisor approved science, math, or engineering courses numbered 200 or above.
EGR. ENGINEERING

EGR-200. INTRODUCTION TO MATERIALS SCIENCE
Credits: 3
Application of materials properties to engineering design. Introduction to atomic arrangements, crystal structures, imperfection, phase diagrams, and structure-property relations. Fundamentals of iron, steel, and non-ferrous materials. The behavior of materials in environmental conditions.

Pre-Requisites
[[CHM-118]]

EGR-201. PROFESSIONALISM AND ETHICS
Credits: 1
Responsibility of an engineer as a professional; ethics in science and engineering; role of professional societies; recent trends in technological innovations; career planning. Review of professional exam. Requirement: Junior standing in engineering.

Pre-Requisites
[[CHM-118]], [[MTH-112]].

EGR-214. MODELING OF PHYSICAL SYSTEMS
Credits: 3
Modeling of physical systems. Engineering applications of Laplace transforms, Fourier series, matrices, statistics and probability, and related topics to solve problems in electromagnetics, heat and mass transfer, control systems, fluid mechanics, robotics, engineering management, and communication systems. Emphasis on the use of simulation packages.

Pre-Requisites
[[EE-211]], [[MTH-112]].

EGR-219. INTRODUCTION TO WEAPONS SYSTEMS
Credits: 3
Introduction to military weapons and warfare, with a focus on how the modern period has resulted in greater complexity and the development of weapons systems. Basic principles of explosives, internal and exterior ballistics, calculation of probabilities of hit given randomness, fire control, guidance algorithms, radar and other sensors, detection and tracking, nuclear weapons and their effects.

Pre-Requisites
[[PHY-202]].

EGR-222. MECHATRONICS
Credits: 3
Introduction to mechatronics system design with emphasis on using sensors to convert engineering system information into an electrical domain, signal conditioning and hardware integration, programming, and using actuators to effect system changes.

Pre-Requisites
[[EE-211]], [[EE-283]], [[ME-140]] and [[PHY-202]].

EGR-227. THIN FILM PROCESSING
Credits: 3
Nucleation and growth theory; crystalline, amorphous, epitaxial growth morphology. Deposition techniques like DC, RF, magnetron sputtering, ion beam sputtering, evaporation, chemical vapor deposition, physical vapor deposition. Structure, properties, and applications for specific thin film processing techniques.

Pre-Requisites
[[EGR-200]], [[PHY-203]].

EGR-391. SENIOR PROJECTS I
Credits: 1
Design and development of selected projects in the field of engineering under the direction of a staff member. Technical as well as economic factors will be considered in the design. A professional paper and detailed progress report are required.

Pre-Requisites
[[EGR-391]].

EGR-392. SENIOR PROJECTS II
Credits: 2
Design and development of selected projects in the field of engineering under the direction of a staff member. Technical as well as economic factors will be considered in the design. This is a continuation of [[EGR-391]]. A professional paper to be presented and discussed in an open forum is required.

Pre-Requisites
[[EGR-391]].

EGR-399. COOPERATIVE EDUCATION
Credits: 1-6
Professional cooperative education placement in a private or public organization related to the student’s academic objectives and career goals. In addition to their work experiences, students are required to submit weekly reaction papers and an academic project to a Faculty Coordinator in the student’s discipline. See the Cooperative Education section of this bulletin for placement procedures. Requirements: Junior standing; minimum 2.0 cumulative GPA; consent of the academic advisor; and approval of placement by the department chairperson.

EGR-498. LABORATORY TOPICS
Credits: Varies with topic
A study of topics of special interest not extensively treated in regularly offered laboratory courses.

Pre-Requisites
Will vary according to the specific topics course.
ME. MECHANICAL ENGINEERING

ME-140. SCIENTIFIC PROGRAMMING
Credits: 3
This course presents an introduction to computer programming with an emphasis on the techniques needed for data analysis and numerical problem solving for scientific and engineering applications. Basic programming idioms are presented including control structures, data types, methods for handling input and output as well as numerical methods such as array computing and vectorization. Emphasis is placed on proper software engineering practice as well as data analysis and presentation.

Pre-Requisites
[[MTH-100]] OR Corequisite [[MTH-111]]

ME-175. INTRODUCTION TO MANUFACTURING & MACHINING
Credits: 1
Familiarizing with traditional machining processes and measuring equipment used in manufacturing. Hands-on experience with traditional and numerical control (NC) machines; various manufacturing processes and fundamentals of metrology.

Pre-Requisites
[[ME-231]], [[ME-180]], [[MTH-112]]

ME-180. CADD LAB
Credits: 1
An introduction to the symbolic and visual languages used in the various engineering fields. The use of the computer in design and drafting and familiarization with various software packages in the CADD (Computer Aided Design and Drafting) laboratory. Blueprint reading and printed circuit layouts. Emphasis will also be placed on the representation and interpretation of data in graphical form as well as the fundamentals of 2-dimensional and 3-dimensional graphic formats.

Pre-Requisites
[[ME-231]], [[ME-180]], [[MTH-112]]

ME-215. INTRODUCTION TO MANUFACTURING PROCESSES
Credits: 3
An introduction to manufacturing which examines traditional processes such as metal forming and casting and advanced manufacturing processes associated with thin film deposition, microfabrication and piezoelectric devices. Quality assurance and quality control issues in manufacturing.

Pre-Requisites
[[ME-232]]

ME-231. STATICS
Credits: 3
Statics of particles, including resolution of forces into components, vector sums, and concurrent force systems. Statics of rigid bodies and the study of moments. Equilibrium of bodies in two- and three-dimensions and determination of reactions. Analysis of trusses and frames. Determination of centroids and moments of inertia. Kinematics of particles, including displacement, velocity, and acceleration.

Pre-Requisites
[[PHY-201]]
Co-Requisites
[[MTH-112]], [[ME-180]]

ME-232. STRENGTH OF MATERIALS
Credits: 3
Analysis of statically determinate and indeterminate structural systems; computation of reactions, shears, moments, and deflections of beams, trusses, and frames. Bending and torsion of slender bars; buckling and plastic behavior.

Pre-Requisites
[[ME-231]], [[EGR-200]], [[ME-180]], [[MTH-112]]

ME-234. DYNAMICS
Credits: 3
This course continues the development of Newtonian mechanics with application to the motion of free bodies and mechanisms. Topics include rectilinear motion, vector calculus, particle motion, inertial and rotating reference frames, rigid body motion, rotational dynamics, linear and rotational momentum, work and kinetic energy, virtual work and collision.

Pre-Requisites
[[ME-231]], [[ME-180]], [[MTH-112]]

ME-298. TOPICS IN MECHANICAL ENGINEERING
Credits: 1-3
Selected topics in the field of mechanical engineering.

Pre-Requisites
Sophomore standing and permission of the instructor.

ME-312. MANUFACTURING SYSTEM ENGINEERING
Credits: 3

Pre-Requisites
Junior standing in mechanical engineering.

ME-314. INVERSE PROBLEMS IN MECHANICS
Credits: 3
Inverse problems are very common in engineering where the outputs are known but the inputs are unknown. This course will show how to properly setup a well-posed inverse problem, how to solve matrix inverses, and conduct hands on experiments by creating strain gage based force transducers.

Pre-Requisites
[[ME-333]]

ME-317. ROBOTICS
Credits: 3
The analysis and design of robots. Class covers the mechanical principles governing the kinematics of robotics. Course topics include forward kinematics and the determination of the closed form kinematic inversion, as well as workspace and trajectory generation. Class also covers the formation and computation of the manipulator Jacobian matrix.

Pre-Requisites
[[EGR-222]] and [[ME-234]]
ME-321. FLUID MECHANICS
Credits: 3
Thermodynamics and dynamic principles applied to fluid behavior and to ideal, viscous and compressible fluids under internal and external flow conditions.

Pre-Requisites
[[ME-231]]

Co-Requisites
Concurrent or after [[ME-322]]

ME-322. ENGINEERING THERMODYNAMICS
Credits: 3

Pre-Requisites
[[MTH-112]]

ME-323. FLUID MECHANICS LABORATORY
Credits: 1
Experiments with and analysis of basic fluid phenomena, hydrostatic pressure, Bernoulli theorem, laminar and turbulent flow, pipe friction, and drag coefficient.
Click here for course fees.

Co-Requisites
[[ME-321]]

ME-324. HEAT TRANSFER
Credits: 3
Fundamental principles of heat transmission by conduction, convection, and radiation; application of the laws of thermodynamics; application of these principles to the solution of engineering problems.

Pre-Requisites
[[ME-321]] and [[MTH-211]]

ME-325. ENERGY SYSTEMS
Credits: 3
Fundamental principles of energy transmission and energy conversion. Comprehension of the physical systems in which the conversion of energy is accomplished. Primary factors necessary in the design and performance analysis of energy systems.

Pre-Requisites
[[ME-322]].

ME-326. HEAT TRANSFER LABORATORY
Credits: 1
Basic heat transfer modes are demonstrated experimentally. This includes conduction, convection, and radiation of heat as well as fin and heat exchanger.
Click here for course fees.

Pre-Requisites
[[ME-321]]

Co-Requisites
Concurrent or after [[ME-324]]

ME-328. COMBUSTION ENGINES
Credits: 3
Investigation and analysis of internal and external combustion engines with respect to automotive applications. Consideration of fuels, carburetion, combustion, detonation, design factors, exhaust emissions and alternative power plants.

Pre-Requisites
[[ME-322]]

ME-332. VIBRATION OF DYNAMIC SYSTEMS
Credits: 3
An introductory course in mechanical vibration dealing with free and forced vibration of single and multi-degrees of freedom for linear and nonlinear systems.
Click here for course fee.

Pre-Requisites
[[ME-234]], [[MTH-211]]

ME-333. MACHINE DESIGN I
Credits: 3
The first of a two-course sequence in design of machine elements dealing with theories of deformation and failure, strength and endurance limit, fluctuating stresses, fatigue and design under axial, bending, torsional, and combined stresses. A study of fasteners, welds, gears, ball-ed roller bearings, belts, chains, clutches, and brakes.

Pre-Requisites
[[ME-232]]

ME-335. ENGINEERING MODELING AND ANALYSIS
Credits: 3
Introduction to finite element method for static and dynamic modeling and analysis of engineering systems. Finite element formulation and computer modeling techniques for stress, plane strain, beams, axisymmetric solids, heat conduction, and fluid flow problems. Solution of finite element equation and post processing of results for further use in the design problem.
Click here for course fee.

Pre-Requisites
[[ME-232]]

Co-Requisites
[[MTH-211]]

ME-337. MICRO-ELECTRO-MECHANICAL SYSTEMS ENGINEERING
Credits: 3
This course explores the principles of MEMS by understanding materials properties, micro-machining, sensor and actuator principles. The student will learn that MEMS are integrated micro-devices combining mechanical and electrical systems, which convert physical properties to electrical signals and, consequently, detection. This course provides the theoretical and exercises the hands-on experience by fabricating a micro-pressure sensor.
Click here for course fees.

Pre-Requisites
Junior standing in engineering
ME-338. MACHINE DESIGN II
Credits: 3
An advanced course in machine design topics that expands upon the concepts of Machine Design I. This course goes into more detail of the basic machine fundamentals introduced previously such as levers, belts, pulleys, gears, cams and power screws. Emphasis is also placed on 3D printing and the future of additive manufacturing.

Pre-Requisites
[ME-333]

ME-340. HEATING, VENTILATION AND AIR CONDITIONING
Credits: 3
Introduction of fundamentals of HVAC design and construction. Study of the psychrometric process and fundamental calculations and layout of HVAC systems. Calculations of heat loss and heat gain in commercial and residential structures.

Pre-Requisites
[ME-322]

ME-384. MECHANICAL DESIGN LABORATORY
Credits: 3
A laboratory for the development of hands-on experience dealing with open-ended problems in mechanical systems. Emphasis on experimental performance, data collection, evaluations, analysis and design. Click here for course fees.

Pre-Requisites
[ME-333]

ME-391. SENIOR PROJECTS I
Credits: 1
Design and development of selected projects in the field of mechanical engineering under the direction of a staff member. Technical as well as economic factors will be considered in the design. A detailed progress report is required. Click here for course fees.

Pre-Requisites
Senior standing in mechanical engineering, [EGM-320]

ME-392. SENIOR PROJECTS II
Credits: 2
Design and development of selected projects in the various fields of mechanical engineering under the direction of a staff member. Technical as well as economic factors will be considered in the design. A professional paper and detailed progress reports are required. This is a continuation of [ME-391]. An open-forum presentation and discussion of the professional paper are required. Click here for course fees.

Pre-Requisites
[ME-391]

ME-395. INDEPENDENT RESEARCH
Credits: 1 - 3
Independent study and research for advanced students in the field of mechanical engineering under the direction of a staff member. A research paper at a level significantly beyond a term paper is required.

Pre-Requisites
Senior standing in mechanical engineering and approval of the department chairperson is required.

ME-396. INDEPENDENT RESEARCH
Credits: 1 - 3
Independent study and research for advanced students in the field of mechanical engineering under the direction of a staff member. A research paper at a level significantly beyond a term paper is required.

Pre-Requisites
Senior standing in mechanical engineering and approval of the department chairperson is required.

ME-397. SEMINAR
Credits: 1-3
Presentations and discussions of selected topics.

Pre-Requisites
Junior or Senior standing in mechanical engineering or special departmental permission.

ME-398. TOPICS IN MECHANICAL ENGINEERING
Credits: 1-3
Click here for course fees.

Pre-Requisites
Junior or senior standing in mechanical engineering.

ME-399. COOPERATIVE EDUCATION
Credits: 1-6
Professional cooperative education placement in a private or public organization related to the student’s academic objectives and career goals. In addition to their work experiences, students are required to submit weekly reaction papers and an academic project to a Faculty Coordinator in the student’s discipline. See the Cooperative Education section of this bulletin for placement procedures. Requirements: minimum junior standing in Engineering; 2.0 cumulative GPA; consent of the academic advisor; and approval of placement by the department chairperson. The co-op option for credit can only be taken one time for either 3 or 6 credits.

PHY. PHYSICS

PHY-198-298-398. TOPICS IN PHYSICS
Credits: variable
Selected topics in the field of physics. These may include one or more of the following: astronomy; geophysics; biophysics; nuclear power and waste; relativity; quantum mechanics; semi-conductors; cryogenics; health physics. May be repeated for credit.

Pre-Requisites
Varies with topic studied.
PHY-395-396. INDEPENDENT RESEARCH  
Credits: 1 - 3  
Independent study and research for advanced students in the field of physics under the direction of a staff member. A research paper at a level significantly beyond a term paper is required.  
Pre-Requisites  
Senior standing and approval of the department chairperson.

PHY-105. CONCEPTS IN PHYSICS  
Credits: 3  
Basic concepts of physical science, including the scientific method, will be studied. Theories, laws, and experiments from mechanics, electricity and magnetism, thermodynamics, optics, and atomic and nuclear physics may be included. Viewpoints will be classical and modern, including quantum and relativistic. Class meets for four hours per week: two hours of lecture and one two-hour lab each week.  
Click here for course fees.  
Pre-Requisites  
No previous background in either science or college-level mathematics is required.

PHY-170. CONCEPTS IN PHYSICS AND CHEMISTRY  
Credits: 4  
An overview of Classical Mechanics, Thermodynamics, and the elementary principles of modern physics, including selected topics in basic chemistry and applications to human health. Emphasis is placed on basic physical and chemical principles and on algebraic calculations, scaling, units conversions, Cartesian graphing, acid and base reactions, and numerical problem solving. Three hours of demonstration and lecture, one hour of recitation, and two hours of lab per week.  
Click here for course fees.  
Pre-Requisites  
Previous courses in chemistry, algebra, and geometry.

PHY-171. PRINCIPLES OF CLASSICAL AND MODERN PHYSICS  
Credits: 4  
An introductory course designed to promote and understanding of the more important fundamental laws and methods of mechanics and electricity and magnetism. Laboratory work to emphasize basic principles and to acquaint the student with measuring instruments and their use, as well as the interpretation of experimental data. Three hours of demonstration and lecture, one hour of recitation, and two hours of lab per week. Co-requisite: [[MTH-111]]  
Click here for course fees.

PHY-174. APPLICATION OF CLASSICAL AND MODERN PHYSICS  
Credits: 4  
An introductory course designed to promote an understanding of the more important fundamental laws and methods of heat, optics, and modern physics. Laboratory work to emphasize basic principles and to acquaint the student with measuring instruments and their use, as well as the interpretation of experimental data. Three hours of demonstration and lecture, one hour of recitation, and two hours of lab per week. Co-requisite: [[MTH-111]]  
Click here for course fees.

PHY-201. GENERAL PHYSICS I  
Credits: 4  
A thorough grounding in the concepts, principles, and laws of mechanics, thermodynamics, and wave motion. Instruction by demonstration and lecture, recitation, problem solving, and experimental work. Three hours of demonstration and lecture, one hour of recitation, and two hours of lab per week. Co-requisite: [[MTH-111]]  
Click here for course fees.

PHY-202. GENERAL PHYSICS II  
Credits: 4  
Electricity and magnetism, optics and light. Three hours of demonstration and lecture, one hour of recitation, and two hours of lab per week.  
Click here for course fees.  
Pre-Requisites  
[[PHY-201]]. Co-requisite [[MTH-112]].

PHY-203. MODERN PHYSICS  
Credits: 3  
Modern physics including the experimental basis, concepts, and principles of atomic and nuclear physics. Three hours of demonstration and lecture per week.  
Pre-Requisites  
[[PHY-202]].

PHY-206. MODERN PHYSICS LAB  
Credits: 1  
Experiments leading to the development of relativity and quantum theory to reinforce and expand upon the learning of fundamental concepts in EM theory, relativity, statistical mechanics, quantum mechanics, solid state physics, and nuclear physics.  
Click here for course fee.  
Pre-Requisites  
[[PHY-202]].  
Co-Requisites  
[[PHY-203]].

PHY-214. MODELING OF PHYSICAL SYSTEMS  
Credits: 3  
Modeling of various problems in physical, chemical, biological, and environmental sciences, particularly physical dynamical systems; includes application of ordinary differential equations, and Laplace, Fourier, and Z transforms to continuous and discrete processes, matrix mechanics and eigenvalue problems, statistics and probability, random processes and distribution functions.  
2 hours of lecture and 2 hours of laboratory per week  
Click here for course fee.  
Pre-Requisites  
[[MTH-211]], [[EGR-140]] or [[CS-125]].
PHY-311. THERMODYNAMICS & STATISTICAL MECHANICS  
Credits: 3  
This course focuses on the laws of thermodynamics and other thermodynamic concepts including entropy, free energy, equilibrium, and fluctuations as well as their pivotal role in physics and other scientific disciplines. Topics in statistical mechanics will be covered including partition functions, ensembles, kinetic theory, and phase transitions. Three hours of lecture per week.  
Pre-Requisites  
[[PHY-203]] and [[MTH-211]].

PHY-312. ANALYTICAL MECHANICS  
Credits: 3  
Employs advanced mathematical tools to study applications in complex mechanical systems. It offers an advanced differential reformulation of Newton’s laws to study dynamical systems in multiple dimensions, conservative force fields, damped and driven oscillations, two-body problem, central forces and planetary motion, and the rotational dynamics of rigid bodies. Additionally, the course delivers a thorough grounding on the calculus of variations, Lagrange’s formalism and Hamiltonian mechanics, all being the essential foundations for the development of modern physics (relativity, quantum mechanics, and quantum field theory). Three hours of lecture per week.  
Pre-Requisites  
[[PHY-202]] and [[MTH-211]].

PHY-314. QUANTUM MECHANICS  
Credits: 3  
This course presents an intermediate level of Quantum Mechanics using the abstract formulation of linear vector spaces in the Dirac formalism. Topics covered include: spin, addition of angular momentum, scattering and bound particles, the harmonic oscillator, two-body problem and central potential wells in 3D, H-atom and H-like atoms, time-independent perturbation theory, identical particles and the He-atom. In addition to the foundations of Quantum Mechanics, the course offers a selection of advanced and modern topics like entanglement and quantum teleportation. Three hours of lecture per week.  
Pre-Requisites  
[[PHY-202]] and [[MTH-211]].

PHY-374. IMAGING IN BIOMEDICINE  
Credits: 3  
This course will cover different aspects of imaging important to medicine and biomedicine including optical microscopy, scanning probe microscopy, scanning electron microscopy, magnetic resonance, ultrasound X-ray, nuclear radiation, microwave and electro-magneto-encephalographic techniques as well as image processing. Three hours of lecture and three hours of lab per week.  
Pre-Requisites  
[[PHY-201]] & [[PHY-202]] or [[PHY-171]] & [[PHY-174]], [[MTH-112]].

PHY-377. BIOPHYSICS  
Credits: 3  
This course presents an overview of the important physical principles governing the behavior of cells and macromolecules. Upper-level mathematics that are useful to understand these phenomena are introduced in a way that is comprehensible to biology majors lacking background beyond basic calculus. In addition to the physical models governing the most ubiquitous molecular and cellular processes, the physics behind the most common experimental techniques used in biology, bioengineering, and biophysics are covered. Three hours of lecture and two hours of lab per week.  
Pre-Requisites  
[[PHY-201]] & [[PHY-202]] or [[PHY-171]] & [[PHY-174]], [[MTH-112]].

PHY-391. SENIOR PROJECT I  
Credits: 1  
Students will plan and execute a research project in the field of physics or at the intersection of physics and another related discipline. Projects can be theoretical, experimental or both and can include the design of unique experiments and simulations. A detailed progress report and presentation are required. Students pursuing a dual degree or double major may be eligible to combine this project with the capstone project of another program (subject to the approval of their advisors in both programs).  
Pre-Requisites  
Senior standing in Physics

PHY-392. SENIOR PROJECT II  
Credits: 2  
Students will plan and execute a research project in the field of physics or at the intersection of physics and another related discipline. This is a continuation of PHY 391. A professional paper and progress report are required. Students will present the results of their work in an open-forum. Students pursuing a dual degree or double major may be eligible to combine this project with the capstone project of another program (subject to the approval of their advisors in both programs).  
Pre-Requisites  
[[PHY-391]]