**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**

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*EGR 391 and 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. Consult with the Cooperative Education coordinator for availability and proper scheduling of Cooperative Education experience.*
EGR. ENGINEERING

EGR-140. SCIENTIFIC PROGRAMMING
Credits: 3
An introduction to computer techniques for engineering design and analysis of components. Mechanisms, systems, and processes. Utilization of computer software packages in problem solving, performance evaluations, demonstration, trouble shooting, and determination of the interrelationships among system components as well as processes. Two hours of lecture and one two-hour lab per week.

Pre-Requisites
MTH-100 OR Corequisite MTH-111

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.

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. Two hours of lecture and one two-hour lab per week.

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.

Co-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. Two one-hour lecture and one three-hour lab per week.

Pre-Requisites
EE-211, EE-283, EGR-140 and PHY-202

EGR-327. 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. Two hours of lecture and two hours of lab per week.

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.
Click here for course fee.

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

ME. MECHANICAL ENGINEERING

ME-395-396. 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-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. Two-hour lab each week.
Click here for course fees.

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. Two hours of lecture and lab per week.
Click here for course fees.

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
EGR-200, ME-180, 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-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

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-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. One three-hour lab per week. 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. One two-hour lab per week. 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. Two hours of lecture and two hours of lab per week. 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, balled 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. Two hours of lecture and two hours of lab per week. Click here for course fee.

Pre-Requisites
ME-232
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. Two hours of lecture and three hours of lab per week. 
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

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. Two hours of lecture and four hours of lab per week. 
Click here for course fees.

Pre-Requisites
Senior standing in mechanical engineering or instructor permission

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-381. An open-forum presentation and discussion of the professional paper are required. 
Click here for course fees.

Pre-Requisites
ME-391

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

Pre-Requisites

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

Pre-Requisites
ME-391

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: Junior standing; minimum 2.0 cumulative GPA; consent of the academic advisor; and approval of placement by the department chairperson.

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 waster; 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 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-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-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 abs 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-203, CHM-115, MTH-211, and MTH-212.

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.

Click here for course fee.

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).

Click here for course fee.

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).

Click here for course fee.

Pre-Requisites  
PHY-391