COMPUTER ENGINEERING
MINOR
Computer Engineering Minor

Minor in Computer Engineering
A 20 to 22-credit Computer Engineering minor is a special and highly focused option for students majoring in Engineering and other related disciplines. The minor consists of the following course requirements:

- [CS-125] – Computer Science I or [EE-140] - Scientific Programming
- [CS-126] – Computer Science II or [EE-247] Programming for Embedded Applications
- [EE-241] – Digital Design
- [EE-345] – Computer Organization
- [EE-342] – Microcontroller Based System Design

One elective course from an Application Area (e.g., [EE-314] – Control Systems; [CS-355] – Computer Networks; or [ME-317] – Robotics)

CS. COMPUTER SCIENCE

CS-198, CS-298, CS-398. TOPICS IN COMPUTER SCIENCE
Credits: Variable
Study of one or more special topics in computer science. May be repeated for credit if different topics are emphasized. Offered when demand warrants.

Pre-Requisites
Varies with topic

CS-115. COMPUTERS AND APPLICATIONS
Credits: 3
An introduction to computers and computing, with emphasis on personal computing in both the Windows and OS X operating systems. Extensive hands-on experience will involve the application of current commercial software (including word processing, database, and spreadsheet). Not open to students who have received credit in any 200-level CS course. Students majoring in either Computer Science or Computer Information Systems will not receive credit for this course.

Pre-Requisites
[CS-125] with grade of 2.0 or better

CS-125. COMPUTER SCIENCE I
Credits: 4
Introduction to information technology and programming (history of computing, text editors, word processing, spreadsheets, introduction to programming), basic data types, functions, decision structures, loops, one- and two-dimensional list structures, testing, debugging, and an introduction to computer graphics. Three hours of lecture and two hours of lab per week. Offered every fall and spring.

Pre-Requisites
Secondary mathematics, including geometry and algebra II.

CS-126. COMPUTER SCIENCE II
Credits: 4
A study of advanced programming concepts, structures, and techniques (professional and ethical issues, testing and debugging, fundamentals of programming, basic data structures—strings, lists, multidimensional arrays, objects, hashes, inheritance, polymorphism, recursion, divide and conquer, machine representation of data, hardware components, machine instructions). Three hours of lecture and two hours of lab per week. Offered every fall and spring.

Pre-Requisites
[CS-125] with grade of 2.0 or better OR equivalent programming experience.

CS-225. COMPUTER SCIENCE III
Credits: 3
A study of the use of a high-level language to implement basic data structures such as strings, lists, arrays, objects, and hashes, and their application to searching, sorting, and hashing. Representation of numbers and strings at the machine level. The course will also include an introduction to the concepts of algorithm design and problem solving with an emphasis on algorithm development, analysis, and refinement. Offered every fall.

Pre-Requisites
[CS-126] with grade of 2.0 or better

CS-226. COMPUTER SCIENCE IV
Credits: 3
A continuation of [CS-225]. Topics include programming language paradigms, advanced use of word processors and spreadsheets, including macros, linked data structures, and an introduction to discrete mathematics, including counting, probability, and graphs. Offered every spring.

Pre-Requisites
[CS-225] with grade of 2.0 or better

CS-246. C AND UNIX
Credits: 3
An introduction to using Unix operating systems, including shells, file manipulation, text editors, filters, and regular expressions. Fundamentals of C programming, including loops, arrays, functions, recursion, pointers, structures, unions, input/output, and system calls.

Pre-Requisites
[CS-126] with grade of 2.0 or better

CS-265. MEDICAL INFORMATICS
Credits: 3
This course will cover basic principles of computer use and information management in health care (including general medicine, dentistry, optometry, and pharmacy). Topics will include basic computing concepts, the characteristics of medical data, and the use of computers in the administrative, diagnostic, and research oriented medical tasks. The course is primarily directed towards students who intend to pursue careers in health-related fields. Offered every spring.

Click here for course fee.
CS-283. WEB DEVELOPMENT I
Credits: 3
An introduction to the development of interactive web sites, including HTML, JavaScript, forms and CGI programs; server side includes cookies, web server configuration and maintenance. Offered in the fall semester of odd-numbered years when demand warrants.
Click here for course fee.

Pre-Requisites
[[CS-126]].

CS-285. MOBILE APPLICATIONS
Credits: 3
An introduction to programming mobile application development. Topics will include cross-platform development; user interface design; touchscreen, GPS, and motion sensing input; memory management; cloud services and network utilization; security and trust considerations; data privacy and ethics.
Click here for course fee.

Pre-Requisites
[[CS-126]] and [[CS-246]].

CS-317. SOFTWARE INTEGRATION
Credits: 3
An introduction to the integration of application programs, including email clients, word processors, spreadsheets, and database systems using Microsoft Office and Visual Basic.
Click here for course fee.

Pre-Requisites
[[CS-126]].

CS-319. PRINCIPLES OF PROGRAMMING LANGUAGES
Credits: 3
A study of the principles that govern the design and implementation of programming languages. Topics include language structure, data types, and control structures. Programming projects will familiarize students with features of programming languages through their implementation in interpreters.
Click here for course fee.

Pre-Requisites
[[CS-226]].

CS-321. SIMULATION AND DATA ANALYSIS
Credits: 3
Methods of handling large databases, including statistical analysis and computer simulations. The emphasis will be upon discrete simulation models with a discussion of relevant computer languages: ARENA, GPSS, and SIMSCRIPT.
Click here for course fee.

Pre-Requisites
[[CS-125]] and [[MTH-111]].
CS-330. COMPUTER ARCHITECTURE
Credits: 3
A study of the design, organization, and structure of computers, ranging from the microprocessors to the latest 'supercomputers.' An emphasis will be placed on machine language, instruction formats, addressing modes, and machine representation of numbers.
Click here for course fee.

Pre-Requisites
[[CS-226]].

CS-334. SOFTWARE ENGINEERING
Credits: 3
A course in 'programming in the large.' Topics include software design, implementation, validation, maintenance, and documentation. There will be one or more team projects.
Click here for course fee.

Pre-Requisites
[[CS-226]].

CS-335. ADVANCED DATABASE CONCEPTS
Credits: 3
Practical experience involving unstructured data collections. Topics cover big data, data mining, predictive modeling, decision analysis and indexing and retrieval including probabilistics, clustering, thesauri and passage based retrieval strategies.
Click here for course fee.

Pre-Requisites
[[CS-226]] or [[CS-340]].

CS-340. ARTIFICIAL INTELLIGENCE
Credits: 3
This course will provide an overview of artificial intelligence (AI) application areas and hands-on experience with some common AI computational tools. Topics include search, natural language processing, theorem proving, planning, machine learning, robotics, vision, knowledge-based systems (expert systems), and neural networks.
Click here for course fee.

Pre-Requisites
[[CS-126]].

CS-350. OBJECT-ORIENTED PROGRAMMING
Credits: 3
Object-oriented concepts and their application to human-computer interaction. Concepts to be covered include objects, classes, inheritance, polymorphism, design patterns, GUI interface guidelines, and design of interfaces. There will be programming projects in one or more object-oriented languages using one or more GUI interface guidelines.
Click here for course fee.

Pre-Requisites
[[CS-226]].

CS-355. COMPUTER NETWORKS
Credits: 3
This course introduces basic concepts, architecture, and widely used protocols of computer networks. Topics include the Open System Interconnection (OSI) model consisting of physical link layer, data layer, network layer, transport layer, session layer, presentation layer, and application layer, the medium access sublayer and LAN, various routing protocols, Transmission Control Protocol (TCP), and Internet Protocol (IP) for internetworking.
Click here for course fee.

Pre-Requisites
[[CS-225]] and [[CS-246]].

CS-363. OPERATIONS RESEARCH
Credits: 3
A survey of operations research topics such as decision analysis, inventory models, queuing models, dynamic programming, network models and linear programming. Cross-listed with [[MTH-363]].
Click here for course fee.

Pre-Requisites
[[CS-125]], and [[MTH-111]].

CS-364. NUMERICAL ANALYSIS
Credits: 3
An introduction to numerical algorithms as tools to providing solutions to common problems formulated in mathematics, science, and engineering. Focus is given to developing the basic understanding of the construction of numerical algorithms, their applicability, and their limitations. Cross-listed with [[MTH-364]]. Offered Spring odd years.

Pre-Requisites
[[MTH-211]]and [[CS-125]] (or equivalent programming experience).

CS-366. 3 DIMENSIONAL ENVIRONMENTS AND ANIMATION
Credits: 3
This course will explore the foundations of 3-dimensional animation processes as they apply to multiple mediums. Students will build computer-based models and environments, texture, light, animate, and render content for Integrative Media projects or as stand-alone pieces. Cross-listed with [[IM-350]].
Click here for course fee.

Pre-Requisites
[[CS-126]] or [[IM-201]].

CS-367. COMPUTER GRAPHICS
Credits: 3
Fees:
Introduction to equipment and techniques used to generate graphical representation by computer. Discussion of the mathematical techniques necessary to draw objects in two- and three-dimensional space. Emphasis on application programming and the use of a high-resolution color raster display.
Click here for course fee.

Pre-Requisites
[[CS-226]].
CS-368. 3 DIMENSIONAL GAME DEVELOPMENT  
Credits: 3  
An overview of simulation, engine-based, and real-time game systems with a focus on theory, creation, and animation of three-dimensional models used within a game context. Cross-listed with [IM-368].

Click here for course fee.

Pre-Requisites  
[[CS-366]]/IM 350 or [CS-367].

CS-370. SPECIAL PROJECTS  
Credits: variable  
Requirements: Senior standing and approval of the department chairperson.

CS-383. WEB DEVELOPMENT II  
Credits: 3  
An introduction to the development of dynamic, database-driven sites, including active server pages, PHP, authentication, session tracking and security, and the development of shopping cart and portal systems.

Click here for course fee.

Pre-Requisites  
[[CS-283]], [CS-325].

CS-391. SENIOR PROJECTS I  
Credits: 1  
Design and implementation of a software project under the direction of a faculty member. Students will normally work in teams. Detailed requirements and design documents are required and will be presented at the end of the semester. Offered every fall.

Click here for course fee.

Pre-Requisites  
[[CS-334]] or [CS-324].

CS-392. SENIOR PROJECTS II  
Credits: 2  
Design and implementation of a software project under the direction of a faculty member. Students will normally work in teams. Production of a finished product, including software and documentation, is required. There will be an open forum presentation of the project at the end of the semester. Offered every spring.

Click here for course fee.

Pre-Requisites  
[[CS-391]].

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

Pre-Requisites  
[[EE-211]].

EE. ELECTRICAL ENGINEERING

EE-211. ELECTRICAL CIRCUITS AND DEVICES  
Credits: 3  

Co-Requisites  
[[MTH-112]].

EE-241. DIGITAL DESIGN  
Credits: 3  
The electronics of digital devices, including Bipolar TTL and CMOS, digital logic functions (e.g., AND, OR, INVERT), Boolean algebra, combinational logic, minimization techniques, digital storage devices, synchronous sequential design, state machines, programmable logic. Three one-hour lectures and one two-hour lab per week.

Click here for course fees.

EE-247. PROGRAMMING FOR EMBEDDED APPLICATIONS  
Credits: 3  
Microcontroller hardware structures. Basic software concepts such as constants, variables, control structures and subroutine calls, based on the 'C' language and as translated to machine language. Mapping of compiled software to the memory of a microcontroller. Embedded programming principles. Basic interactions with peripherals. Interrupts and their use. Debugging. Three hours of lecture and lab per week.

Click here for course fees.

Pre-Requisites  
[[EGR-140]] or [CS-125].

EE-251. ELECTRONICS I  
Credits: 3  
Circuit concepts involving nonideal components, particularly diodes, bipolar transistors, and MOS transistors. Bias, load line and signal amplification principles. Analysis and design of power supply and amplifier circuits, including power amplifiers. Simulation of circuits for design and analysis.

Pre-Requisites  
[[EE-211]].

EE-252. ELECTRONICS II  
Credits: 4  
Multi-transistor amplifiers, operational amplifiers. Frequency response and the design of filters and amplifiers to meet frequency specifications. Feedback in amplifier design and oscillators. Three one-hour lectures and one three-hour lab per week.

Click here for course fees.

Pre-Requisites  
[[EE-251]], [[EE-283]], [[MTH-112]], and [PHY-202]].
EE-271. SEMICONDUCTOR DEVICES
Credits: 3
Basic properties of semiconductors and their conduction processes, with special emphasis on silicon and gallium arsenide. Physics and characterizations of p-n junctions. Homojunction and heterojunction bipolar transistors. Unipolar devices including MOS capacitor and MOSFET. Microwave and photonic devices.

Pre-Requisites
[CHM-117], [PHY-202].

EE-283. ELECTRICAL MEASUREMENTS LAB
Credits: 1
A laboratory for the development of measurement techniques and use of electrical instruments for the measurement of various electrical quantities. One two-hour lab per week.

Co-Requisites
[EE-211]

EE-298. TOPICS IN ELECTRICAL ENGINEERING
Credits: 1-3
Selected topics in the field of electrical engineering. Requirements: Sophomore standing and permission of the instructor.

Pre-Requisites
Sophomore standing and permission of the instructor.

EE-314. CONTROL SYSTEMS
Credits: 3

Pre-Requisites
[EE-211] and [EGR-214] (or [PHY-214])

EE-325. ENERGY CONVERSION DEVICES
Credits: 3
Magnetic circuit calculations. Principle of operation and applications of transformers, DC machines, synchronous machines, and induction motors. Applications of power electronics. Direct energy conversion schemes. Lecture and lab.

Pre-Requisites
[EE-211].

EE-337. ENGINEERING ELECTROMAGNETICS I
Credits: 3
Waves and phasors; concepts of flux and fields; transmission line, Smith chart, and impedance matching; vector calculus; Maxwell’s equations for electrostatic and magnetostatic fields.

Pre-Requisites
[EGR-214] (or [PHY-214]), [PHY-202].

EE-339. ENGINEERING ELECTROMAGNETICS II
Credits: 4
Maxwell’s equation for time-varying fields; boundary conditions and boundary value problems; plane wave propagation; reflection, refraction, and wave guides; stripline; s-parameters and microwave devices; directional coupler, attenuator, radiation and antennas; satellite communication systems and radar sensors. Three hours of lecture and one three-hour lab per week.

Pre-Requisites
[EE-337].

EE-342. MICROCONTROLLER BASED SYSTEM DESIGN
Credits: 3
Microprocessor architecture, the microcontroller based system design context, and peripheral interfacing. C and machine language programming and debugging, and embedded applications. Associated laboratory exercises include topics such as stand-alone system programming, interfacing to peripherals, interrupts, timers, analog data acquisition, and intercomputer communications. Two hours of lecture and one two-hour lab per week.

Pre-Requisites
[EE-241], and either [EE-247] or [CS-126] as corequisites.

EE-345. COMPUTER ORGANIZATION
Credits: 3
Number representation, digital storage devices, and computational units, bus structures; execution sequences and assembly language concepts; control units with horizontal and vertical microcoding; addressing principles and sequencing; microprocessors; basic input and output devices; interrupts; survey of RISC principles including pipelined execution. Lecture and lab.

Pre-Requisites
[EE-241].

EE-381. MICROFABRICATION LAB
Credits: 3
The theoretical and practical aspects of techniques utilized in the fabrication of bipolar junction transistors (BJTs). Includes crystal characteristics, wafer cleaning, oxidation, lithography, etching, deposition, diffusion, metallization, process metrics, and device characterization. One-and-a-half hour lecture and one four-hour lab per week. Requirement: Junior engineering standing.

Pre-Requisites
Wilkes University Undergraduate Bulletin 2018 - 2019

EE-382. MODERN COMMUNICATION SYSTEMS
Credits: 4
Introduction to probability and statistics and their use in communication systems. Fundamental properties of signals, principles of signal processing, multiplexing, modulator-demodulator design, noise and its effects. Sampling theorem and Nyquist’s criteria for pulse shaping; signal distortion over a channel; line coding; signal to noise ratios, and performance comparison of various communication systems.

Pre-Requisites
[EE-252], [EE-337], [EGR-214] (or [PHY-214]).
EE-391. SENIOR PROJECTS I  
**Credits:** 1  
Design and development of selected projects in the field of electrical 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. Requirement: Senior standing in engineering.  
[Click here for course fees.](#)  

EE-392. SENIOR PROJECTS II  
**Credits:** 2  
Design and development of selected projects in the field of electrical 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 the [EE-391]. A professional paper to be presented and discussed in an open forum is required.  
[Click here for course fees.](#)  

EE-398. TOPICS IN ELECTRICAL ENGINEERING  
**Credits:** 3  
Requirement: Junior standing in engineering.

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**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]]  

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.  

**Co-Requisites**  
[IPHY-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 [IPHY-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.  

**Pre-Requisites**  
[EGR-200], [IPHY-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**  
Senior standing in engineering  

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-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.
Click here for course fees
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.
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.
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
[[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, belted 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

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.

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.

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.

Pre-Requisites  
Previous courses in chemistry, algebra, and geometry.

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-211. 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]], [[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]