Department of Computer Science, Engineering, Mathematics, Physics, and Statistics

Courses

CS 100, Introduction to Programming, 3 Units

Students in this course are introduced to basic programming concepts using a suitable and modern programming language, with a strong emphasis on problem solving through programming fundamentals such as variables, expressions, data types, branching, loops, functions, lists, dictionaries, and file input/output. Although the course may use an object-oriented language, object-oriented principles are not covered, as the course is intended to provide non-computer-science majors the tools needed to be successful in carrying out common programming tasks in their fields, such as basic scripting, data analysis, and automation. In-class exercises and several programming projects are included.
Corequisite: MATH 110

CS 110, STEM as Vocation, 3 Units

This course explores two topics. The first topic is methods to apply STEM skills to solve real world challenges that have positive social impact. During your college education you will learn technical skills that can be applied for positive impact on the lives of those around you (near and globally) and to further God's Kingdom here on Earth. The second topic in this course is the exploration of intercultural skills. This is important since you will be required to work with individuals of diverse ethnic backgrounds and you may have to work across cultures. In addition, we live in a multi-ethnic society so developing these types of capabilities is a valuable life skill. *Meets the General Education Requirement: Intercultural Competence.*

CS 115, Impact of Social Media, 3 Units

Social Media has dramatically transformed human interaction in recent decades. The development of platforms such as TikTok, Instagram, Twitter, Facebook, LinkedIn, etc. has impacted humanity on a deeply personal level, facilitated social movement, and even fueled revolutions. Misinformation and counterintelligence have mushroomed. Mental health and self-esteem have degraded. Monitoring, control, and censorship of Social Media have become methods in which various entities have sought to gain information and influence. The platforms have continuously developed services designed to enlarge their user base, enhance engagement, and ultimately monetize information. This course provides a deep investigation of the impacts of Social Media on society. *Meets the General Education Requirement: Social Science.*

CS 120, Introduction to Computer Science I, 4 Units

This course introduces students to object-oriented programming, with an emphasis on problem solving, design and analysis of algorithms, and programming principles. Course material also covers principles of object-oriented and structured programming, problem analysis, and documentation. Attendance at a weekly computer lab is required. Students complete a number of programming projects, and learn how to effectively communicate technical matters orally. *Meets the General Education Requirement: Oral Communication (CS 120+CS 290+CS 480), GE:Oral Communication (ENGR 120+ENGR 240+ENGR 480).*

CS 125, Introduction to Computer Science II, 4 Units

This course is a continuation of object-oriented programming and other topics from ENGR 120/CS 120, and provides an introduction to arrays, inheritance, file I/O, and GUIs. Problem analysis, program design, development and implementation, and related topics are covered. Lab is required. Students complete a number of programming projects. Lecture, 3 hours; lab, 3 hours.
Prerequisite: CS 120/ENGR 120

CS 150, Operating Systems, 3 Units

This course provides an introduction to the basic functions of modern operating systems, including multitasking, process synchronization, deadlocks, memory management, virtual memory, file systems, protection, and security. The course also includes a comparative analysis of several popular operating systems.
Prerequisite: CS 120/ENGR 120

CS 160, Discrete Structures, 3 Units

Students in this course explore the mathematical elements of computer science, including propositional logic, predicate logic, sets, functions and relations, combinatorics, mathematical induction, recursion, algorithms, matrices, graphs, trees, and Boolean logic. Attention is given to the direct applications to computer science.
Prerequisite: MATH 110 or MATH 130

CS 205, Microcomputer Software Tools, 3 Units

This PC-based course covers the basics of MS Windows and the use of applications software as problem-solving tools. In-depth coverage of popular word processing, database, and spreadsheet packages is included.

CS 230, Systems Programming and Operating Systems, 3 Units

This course provides an in-depth study of systems programming using the C language and Linux operating system. Applications include programming projects in threads, signals, memory, and critical sections. It also provides an introduction to the basic functions of modern operating systems. These include multitasking, process synchronization, deadlocks, memory management, virtual memory, file systems, protection, and security.
Prerequisite: CS 125/ENGR 125

CS 240, Assembly Language Programming, 3 Units

This programming class includes the architecture and organization of microcomputer systems, fundamentals of assemblers, assembly language programming, and advanced topics on the Intel 80X86 family of microprocessors. Students write several programs which are assembled and run on Intel 80X86-based microcomputers. Students become proficient at keyboard, screen, and disk I/O as well as character manipulation and screen graphics.
Prerequisite: CS 125/ENGR 125

CS 242, Digital Logic Systems, 4 Units

This course covers Boolean algebra, Karnaugh maps, logic gates, combinational circuit design, sequential circuits analysis and design, Register, and counter and memory system analysis and design, as well as laboratory experiments with TTL logic gates, flip-flops, and counters. Students also learn how to effectively communicate technical matters orally. *Meets the General Education Requirement: GE:Oral Communication (ENGR 120+ENGR 240+ENGR 480).*
Prerequisite: CS 125/ENGR 125

CS 260, Algorithms and Data Structures, 3 Units

This course provides a study of algorithms and their related data structures, including linear lists, linked lists, trees, graphs, sorting techniques, and dynamic storage allocation. Applications are implemented using an appropriate computer language.
Prerequisite: CS 125/ENGR 125

CS 290, Database Management Systems, 3 Units

This course covers database concepts; relational and nonrelational database systems; database environment, theory, and applications; and design, development, and implementation of database systems. Students develop a practical database project utilizing a popular database development system, and generate user interfaces and reports. Students also learn how to make persuasive technical arguments concerning common database tradeoffs that must be considered when choosing a database in a real-world project, and are instructed on how to effectively communicate technical matters orally. *Meets the General Education Requirement: Oral Communication (CS 120+CS 290+CS 480).*
Prerequisite: CS 125/ENGR 125

CS 315, Fundamentals of Network Administration, 3 Units

This course provides an introduction to the three key network management issues: cost analysis, security, and administration. Case studies and laboratory exercises supplement the lecture material.
Prerequisite: CS 125/ENGR 125

CS 325, Telecommunications and Interfacing, 3 Units

The principles, protocols, methods, and standards of telecommunications, voice and data communication concepts, networking fundamentals, system configuration, and state-of-the-art practical technology are covered in this course, which includes some hands-on training.
Prerequisite: CS 125/ENGR 125

CS 360, Computer Architecture and Organization, 3 Units

This course covers the architecture and organization of computer systems, including hardware/software design considerations, implementation, interrelationships, and performance. Fundamentals of assemblers and assembly language programming using the MIPS instruction set are included, as is the use of combinational and sequential logic in the components of CPUs, buses, and interfaces. Details include input/output, memory hierarchies, pipelining, ALU operations, and CPU control. Processors include CISC and RISC, as well as multiprocessor systems. Students also take part in several programming and modeling projects that model key computer architecture components.
Prerequisite: CS 260/ENGR 260 or ENGR 240

CS 363, Web Programming, 3 Units

This course is a study of website development, emphasizing web-based programming using open-source software including Apache Server, PHP, Linux, XHTML, CSS, JavaScript and DHTML, MySQL, and others. The concepts, principles, procedures, methods, tools, and techniques used in the development and management of internet websites are covered, including the design, construction, implementation, testing, and maintenance of complex websites using cutting-edge tools. Sites are developed on the Linux platform. Each student makes assigned presentations, develops small internet projects, serves on a development team, and implements part of one major term project.
Prerequisite: CS 125/ENGR 125

CS 370, Compiler Construction, 3 Units

This course covers some fundamental knowledge of languages and automata as well as algorithms and implementation of compiler construction. Regular languages, context-free languages, and context-sensitive languages are covered. Finite-state automata, push-down automata, and multistack push-down automata are covered. Lexical analyzer and parser techniques are covered in depth, as well as symbol table generation and optimization.
Prerequisite: CS 260/ENGR 260

CS 430, Artificial Intelligence, 3 Units

Principles of artificial intelligence, study, design, and application of computer systems that model human intelligence are the focus of this course. Some of the specific topics included in this course are search (informed, uninformed, adversarial, etc.), constraint satisfaction problems (CSPs), knowledge representation, probabilistic modeling, and machine learning. Significant programming projects are assigned to enhance student's abilities to apply course algorithms and knowledge.
Prerequisite: CS 260/ENGR 260

CS 432, Machine Learning, 3 Units

This course covers introductory machine learning topics, including supervised and unsupervised learning, linear and logistic regression, neural networks, support vector machines, recommender systems, and more. Coursework includes instruction and programming assignments in algorithmic implementations and high-level library usage. Students also apply machine learning techniques to a unique research project.
Prerequisite: CS 260/ENGR 260

CS 435, Advanced Database Application Programming, 3 Units

PL/SQL, Oracle's programming language for stored procedures, delivers a world of possibilities for your database programs. PL/SQL supplements the standard relational database language, SQL, with a wide range of procedural features, including loops, IF-THEN statements, procedures, functions, packages, and database triggers-all closely integrated with the Oracle database server. The Oracle PL/SQL language is a flexible procedural extension to SQL and increases productivity, performance, scalability, portability, and security. In this course, students gain the practical knowledge to write PL/SQL programs, and learn to build stored procedures, design and execute modular applications, and increase the efficiency of data movement.
Prerequisite: CS 290

CS 440, Mobile App Development, 3 Units

This course serves as an introduction to mobile app development, with students building several cross-platform apps using cutting-edge technologies that target the Android and iOS operating systems. Topics include authentication, component creation and layout, state management, HTTP/API requests, push notifications, navigation, datastore (or database) connection, and server-side programming using cloud-based server/serverless infrastructure.
Prerequisite: CS 125

CS 452, Internet of Things, 3 Units

This course covers the fundamental aspects of the Internet of Things (IoT), including devices, protocols, security, and product development. Through hands-on labs and projects, students develop the ability to build IoT devices and systems, and a final project showcases their ability to plan, design, and execute their own IoT devices and systems. Students become proficient in embedded programming, cross-compilation, web servers and clients, basic digital electronics, communications protocols, and special programming techniques.
Prerequisite: ENGR 125/CS 125, and CS 230 or ENGR 240.

CS 455, Numerical Analysis, 3 Units

This course covers numerical and approximation methods, including solutions of functions in single and multi-variables, interpolation, numerical differentiation and integration, and numerical methods for differential equations. Applications are programmed using an appropriate language.
Prerequisite: MATH 295 and CS 120

CS 460, Software Project, 3 Units

Each student in this course completes an independent project in the development of a nontrivial software system for an application of the student's choice.
Prerequisite: CS 260/ENGR 260 and CS 290; or instructor permission

CS 465, Team Software Project, 1-3 Units

The team of students in this course completes the development of a nontrivial software system for an application of their choosing.
Prerequisite: CS 125/ENGR 125 or instructor consent.

CS 470, Software Engineering, 3 Units

This course includes a study of the concepts, principles, techniques, methods, procedures, and documents of software engineering. Emphasis is on systematic approaches to software engineering and the software life cycle. Each student participates in a major team project. *Meets the General Education Requirement: Integrative and Applied Learning.*
Prerequisite: CS 260/ENGR 260, CS 290, and at least 32 computer science units.

CS 480, Senior Capstone Project, 3 Units

The primary goal for students in this course is to implement a major team-based software product based on their own software documentation and planning from the previous semester. As a secondary goal, students study and practice software engineering concepts, principles, and methodologies relevant to the implementation phase of software engineering. Students also learn how to prepare and present a technical demo aimed at "selling" their product. *Meets the General Education Requirement: Oral Communication (CS 120+CS 290+CS 480).*
Prerequisite: CS 470

CS 484, Cyber Security, 3 Units

In this course, students systematically study the fundamental principles of computer system security, including authentication, access control, capability, security policies, sandbox, software vulnerabilities, and web security, with most of these principles studied within the scope of concrete systems such as Linux and Windows. The course emphasizes "learning by doing," requiring students to conduct a series of lab exercises through which students enhance their understanding of the principles and learn to apply them to solve real-world problems.
Prerequisite: CS 230, CS 260/ENGR 260

CS 491, Computer Science Internship, 1-3 Units

This course gives students practical experience in computer science and computer information systems as they complete a computer science internship in a nonacademic facility, preferably off campus but under the joint supervision of a computer science faculty member and an outside mentor. A total of 3 units is required to satisfy the General Education Integrative and Applied Learning requirement. *Meets the General Education Requirement: Integrative and Applied Learning.*
Prerequisite: Sophomore standing in computer science major and department approval.

CS 495, Topics in Computer Science, 3 Units

This course presents timely and new topics in computer science, with different material covered each time the course is offered. Most topics require prerequisites, which vary according to the topic. The course may be repeated for credit.
Prerequisite: Department consent (note course description).

CS 496, Writing 3: Ethics in Computing and Engineering, 3 Units

This course equips students with the skills to write in several genres that are relevant to Computing and Engineering, such as resumes, cover letters, professional memos, and research proposals. Students complete reading assignments on the topics of writing and ethics as applied to Computing and Engineering, then weekly writing assignments based upon the reading. The course culminates in a portfolio of the writing completed throughout the semester. *Meets the General Education Requirement: Writing 3: Writing in the Disciplines.*
Prerequisite: Writing 2 (or equivalent)

CS 497, Readings, 1-4 Units

This course consists of assigned readings, discussions, and writing arranged between and designed by student and professor. An independent study fee is assessed for each enrollment in this course.
Prerequisite: Junior or senior standing and department permission.

CS 498, Directed Research, 1-4 Units

Students in this course learn about research design and technique and gain experience in the research process. The 1-unit expectation encompasses no fewer than 30 hours of work with accompanying reading, log, writing, and seminar presentation within the department or in a university research symposium. No more than 1 unit may be used to fulfill preparatory readings requirement. An independent study fee is assessed for each enrollment in this course.
Prerequisite: Junior or senior standing and department permission.

CS 499, Thesis/Project, 1-4 Units

In this senior-level "capstone" type of independent study/research experience, students participate in a unique project with a sophisticated level of research, synthesis, analysis, and communication. The 1-unit expectation encompasses no fewer than 30 hours of work with accompanying readings, log, instructor discussions, and writing of summary analysis and conclusions. The project may result in a formal thesis, published article, electronic media, annotated recital, or artistic creation of a material form. No more than 1 unit may be used to fulfill preparatory readings requirement. An independent study fee is assessed for each enrollment in this course.
Prerequisite: Junior or senior standing and department permission.

CS 532, Machine Learning, 3 Units

This course covers machine learning topics including supervised and unsupervised learning, linear and logistic regression, neural networks, support vector machines, recommender systems, and more. Coursework includes instruction and programming assignments in algorithmic implementations and high-level library usage. Students also apply machine learning techniques to a unique research project.
Prerequisite: Instructor permission required

ENGR 101, Introduction to Engineering and Computing, 3 Units

Students in this course get an overview of engineering and computing as creative and responsive professions, and learn about the qualifications of engineers and computer scientists and the ways in which they study, think, work, create, design, and communicate. Course material also covers the impact of engineering and computing solutions in global, economic, and societal contexts; case studies of effective civic, governmental, and social engagement; and engineering and computing ethics. *Meets the General Education Requirement: Civic Knowledge and Engagement.*

ENGR 110, STEM as Vocation, 3 Units

This course explores two topics. The first topic is methods to apply STEM skills to solve real world challenges that have positive social impact. During your college education you will learn technical skills that can be applied for positive impact on the lives of those around you (near and globally) and to further God's Kingdom here on Earth. The second topic in this course is the exploration of intercultural skills. This is important since you will be required to work with individuals of diverse ethnic backgrounds and you may have to work across cultures. In addition, we live in a multi-ethnic society so developing these types of capabilities is a valuable life skill. *Meets the General Education Requirement: Intercultural Competence.*

ENGR 120, Introduction to Computer Science I, 4 Units

This course introduces students to object-oriented programming, with an emphasis on problem solving, design and analysis of algorithms, and programming principles. Course material also covers principles of object-oriented and structured programming, problem analysis, and documentation. Attendance at a weekly computer lab is required. Students complete a number of programming projects, and learn how to effectively communicate technical matters orally. *Meets the General Education Requirement: Oral Communication (CS 120+CS 290+CS 480), GE:Oral Communication (ENGR 120+ENGR 240+ENGR 480).*
Prerequisite: MATH 110 (may be taken concurrently) or proven competence in college algebra.

ENGR 125, Introduction to Computer Science II, 4 Units

This course is a continuation of object-oriented programming and other topics from ENGR 120/CS 120, and provides an introduction to arrays, inheritance, file I/O, and GUIs. Problem analysis, program design, development and implementation, and related topics are covered. Lab is required. Students complete a number of programming projects. Lecture, 3 hours; lab, 3 hours.
Prerequisite: ENGR 120/CS 120

ENGR 150, Introduction to Mechanics, 3 Units

This course gives students an understanding of forces, moments, and the states and conditions of equilibrium of rigid bodies. It also provides useful and practical insights into internal forces and friction. Further, this course deals with the motion of bodies under the action of forces with two parts: 1) kinematics, the study of motion without reference to the forces that cause motion; and 2) kinetics, which relates the action of forces on bodies to their resulting motions.
Prerequisite: MATH 165, PHYC 165

ENGR 160, Discrete Structures, 3 Units

Students in this course explore the mathematical elements of computer science, including propositional logic, predicate logic, sets, functions and relations, combinatorics, mathematical induction, recursion, algorithms, matrices, graphs, trees, and Boolean logic. Attention is given to the direct applications to computer science.
Prerequisite: MATH 150

ENGR 210, Engineering Thermodynamics, 3 Units

Students in this course learn classical thermodynamics and its engineering applications. Topics include energy and its transfer, properties of pure substances, the first and second laws of thermodynamics, control volume, irreversibility and availability, gas power cycles, vapor and combined power cycles, and refrigeration.
Prerequisite: PHYC 165, MATH 165

ENGR 215, Electrical Circuits and Systems, 4 Units

This course covers resistive circuits with dependent and independent sources, node and loop analyses, reactive elements and circuits, steady state solution for RLC circuits with sinusoidal inputs, resistive and reactive power, three-phase systems, motors and generators, time domain analysis of circuits, transient responses, Laplace transforms, and Fourier series. Laboratory exercises include steady state and transient circuits design and measurements.
Prerequisite: MATH 166

ENGR 240, Digital Logic Systems, 4 Units

This course covers Boolean algebra, Karnaugh maps, logic gates, combinational circuit design, sequential circuits analysis and design, Register, and counter and memory system analysis and design, as well as laboratory experiments with TTL logic gates, flip-flops, and counters. Students also learn how to effectively communicate technical matters orally. *Meets the General Education Requirement: GE:Oral Communication (ENGR 120+ENGR 240+ENGR 480).*
Prerequisite: CS 125/ENGR 125

ENGR 245, Electronics, 4 Units

This course covers amplifier basics; multistage, feedback, and operational amplifiers; wave-shaping and waveform generation; digital electronics; bipolar and CMOS logic; and switching circuits. Laboratory exercises include significant design experience.
Prerequisite: ENGR 215

ENGR 260, Algorithms and Data Structures, 3 Units

This course provides a study of algorithms and their related data structures, including linear lists, linked lists, trees, graphs, sorting techniques, and dynamic storage allocation. Applications are implemented using an appropriate computer language.
Prerequisite: ENGR 125/CS 125

ENGR 271, Advanced Math for Engineers, 4 Units

This course is an introduction to topics in advanced mathematics necessary in most engineering fields. Beginning with key concepts in vector calculus and matrix algebra, the course also covers orthogonal functions, Fourier series, boundary-value problems in several coordinate systems, and the integral transform method. Additional topics may include partial differential equations and complex analysis.
Prerequisite: MATH 270

ENGR 281, Statics, 3 Units

Statics is the branch of physical science that deals with the rest state of bodies under the action of forces. It also includes resultants of force systems and equilibrium on rigid bodies using vector algebra, friction, centroids and centers of gravity, and moments of inertia of areas and masses.
Prerequisite: PHYC 165

ENGR 282, Dynamics, 3 Units

Dynamics is the branch of mechanics that deals with the motion of bodies under the action of forces. Dynamics has two distinct parts: kinematics, the study of motion without reference to the forces that cause motion; and kinetics, which relates the action of forces on bodies to the resulting motions of bodies.
Prerequisite: PHYC 165; ENGR 281 or ENGR 150; or instructor consent

ENGR 310, Discrete Systems Modeling and Simulation, 3 Units

Discrete systems consist of processes in which discrete events occur at asynchronous times. In discrete systems, events in any component of the system may affect future events in other system components. Models of discrete systems account for the occurrences of events and the conditions necessary for events to occur. This course deals with construction of models for discrete systems, theory for the behavior of the discrete system and its components, and use of simulation software to examine the behavior of discrete systems. Topics include modeling techniques, introduction to queueing theory, random number generation, discrete event simulation, Monte Carlo simulation, simulated data analysis, and simulation variance reduction techniques.
Prerequisite: MATH 361 and CS 120/ENGR 120

ENGR 325, Control Systems, 3 Units

This course introduces systems and their modeling and control, exploring open- and closed-loop control, feedback, transfer functions, signal flow graphs, stability, and root locus methods. Frequency response methods and Nyquist and Bode diagrams are used for system representation. PID compensators, state-space representation, and digital implementation of control systems are also studied.
Prerequisite: ENGR 215 and MATH 270.

ENGR 335, Embedded Systems, 4 Units

Embedded systems are found in most computing systems outside of traditional desktop/laptop/server computers, such as in cars, household appliances, handheld electronics, video game consoles, and wearable technologies. This course provides an introduction to programming embedded systems, covering fundamental topics such as timing diagrams, basic coding operations and datatypes (e.g., binary, hexadecimal, bitwise/shift operators, etc.), state machines (synchronous and concurrent), I/O, and peripheral connections. Laboratory experience includes microprocessor-based design projects with real hardware and electronic components.
Prerequisite: ENGR 240 and CS 125/ENGR 125

ENGR 340, Digital Signal Processing, 3 Units

Students in this course learn about discrete-time and sampled-data signals and systems, and their representations using z-transforms, as well as digital filters, FIR and IIR filters, stability, and round-off errors. They design different types of digital filters such as Butterworth, Chebychev, and others. The basics of discrete Fourier transforms and the fast Fourier transform (FFT) algorithm are introduced.
Prerequisite: CS 120 and MATH 165

ENGR 345, Systems Engineering Principles, 3 Units

This course explores the foundations of systems engineering processes and practices, including basic systems engineering processes and the roles of systems engineering professionals in a global business environment, as well as a discussion of current systems issues. It also covers the principles of mechanical drawing and computer-aided design (CAD) for systems engineering applications.
Prerequisite: ENGR 215 or ENGR 240

ENGR 350, Computer Networks, 3 Units

This course introduces the basics of computer networks, including the seven-layer ISO model for networks, with layers 2, 3, and 4 studied in detail. Medium access control protocols and TCP/IP are presented, as well as wireless LAN standards. An introduction to emerging wireless networks is also included.
Prerequisite: ENGR 215, MATH 361

ENGR 355, Communications Systems, 3 Units

This course provides an introduction to the principles of communication systems, including signal representation in time and frequency domains, Fourier series and transforms, analog amplitude, frequency and phase modulation systems, noise effects, applications to radio transmission, digital modulation (ASK, FSK, and PSK [binary and M-ary variants]), noise effects and error probabilities, error detection and correction, block and convolutional codes, and elements of information theory, modulation, and coding applications in wireless, satellite, and optical transmission systems.
Prerequisite: CS 120 and MATH 165

ENGR 360, Computer Architecture and Organization, 3 Units

This course covers the architecture and organization of computer systems, including hardware/software design considerations, implementation, interrelationships, and performance. Fundamentals of assemblers and assembly language programming using the MIPS instruction set are included, as is the use of combinational and sequential logic in the components of CPUs, buses, and interfaces. Details include input/output, memory hierarchies, pipelining, ALU operations, and CPU control. Processors include CISC and RISC, as well as multiprocessor systems. Students also take part in several programming and modeling projects that model key computer architecture components.
Prerequisite: CS 260/ENGR 260 or ENGR 240

ENGR 370, Cyber Physical Systems Security [Proposed], 3 Units

In this course, students systematically study the fundamental principles of computer system security, including authentication, access control, capability, security policies, sandbox, software vulnerabilities, and web security, with most of these principles studied within the scope of concrete systems such as Linux and Windows. The course emphasizes "learning by doing," requiring students to conduct a series of lab exercises through which students enhance their understanding of the principles and learn to apply them to solve real-world problems.
Prerequisite: CS 260/ENGR 260

ENGR 380, Systems Design, 3 Units

Students in this course examine the techniques for developing, analyzing, and portraying design and life cycle systems requirements. They also apply the principles of system design to real-world systems, and learn the use of tools and techniques including quality function deployment and enhanced block flow diagrams.
Prerequisite: ENGR 345

ENGR 384, Mechanics of Materials, 3 Units

This course covers plane stress and strain, principal stresses and strains, Mohr's Circle, properties of materials, stress-strain diagrams, generalized Hooke's Law for isotopic materials, design loads, working stresses, factors of safety, statically indeterminate axially loaded members, torsional shearing stresses and displacements, combined axial and torsional loads, flexural and transverse shear stresses, shear and moment diagrams, and beams of two materials.
Prerequisite: PHYC 165; ENGR 281 or ENGR 150

ENGR 390, Green Power Systems, 3 Units

It is being widely widely recognized that the generation of electric power must be performed in a way that is ecologically responsible. This course provides students with the knowledge to design electric power systems that use energy from natural sources such as sunlight, wind, rain, tides, plants, algae, and geothermal heat. The design approach is from the system level down to the components.
Prerequisite: ENGR 345

ENGR 410, Engineering Management and Economics, 3 Units

Students in this course examine strategies for management during all phases of the lifecycle of an engineering project, including initial planning, implementation, assessment, and termination. Management strategies include resource allocation, budgeting, performance monitoring, and optimizing cost and time. Economic principles including time value of money and cash flows are applied to management topics. *Meets the General Education Requirement: Writing 3: Writing in the Disciplines.*
Prerequisite: ENGR 380

ENGR 420, Decision and Risk Analysis, 3 Units

This course addresses the various types of real-life assessment that must be conducted in order for a large-scale engineering project to be successful, including reliability, probability of risk, decision analysis, and cost-benefit analysis. The decision-making process that accompanies these assessments must be conducted in the presence of significant uncertainty, so course material reviews basic principles of probability theory and statistics. Finally, because large-scale engineering projects involve significant budgets, engineers must be conversant in the language of money, public policy, and economics, so the course concludes with a vital section on cost-benefit analysis.
Prerequisite: ENGR 345

ENGR 452, Internet of Things, 3 Units

This course covers the fundamental aspects of the Internet of Things (IoT), including devices, protocols, security, and product development. Through hands-on labs and projects, students develop the ability to build IoT devices and systems, and a final project showcases their ability to plan, design, and execute their own IoT devices and systems. Students become proficient in embedded programming, cross-compilation, web servers and clients, basic digital electronics, communications protocols, and special programming techniques.
Prerequisite: ENGR 125/CS 125, and CS 230 or ENGR 240.

ENGR 470, Senior Design Project I, 2 Units

In this first part of a two-semester engineering design project experience, students are encouraged to engage in group-based projects and industrial sponsorship, and must complete a fully documented design solution by the end of the course. Use of oral and written professional communication skills is emphasized.
Prerequisite: CS 125/ENGR 125, ENGR 150, ENGR 240, ENGR 245, and PHYC 166.

ENGR 480, Senior Design Project II, 2 Units

This course involves the implementation of the design developed in ENGR 470, including prototyping and testing. Students are also instructed on how to prepare and present a technical demo aimed at "selling" their product. *Meets the General Education Requirement: GE:Oral Communication (ENGR 120+ENGR 240+ENGR 480).*
Prerequisite: ENGR 470

ENGR 491, Engineering Internship, 1-3 Units

Students in this course gain practical experience in engineering as they complete a semester-long engineering project under the joint supervision of an engineering faculty member and an outside mentor. Through actual and practical working experience in an internship, students synthesize the statement of the problem and the solutions they face in the working environment, based on the application of learning from multiple courses from various fields. These include, but are not limited to, courses in engineering (mechanics, electronics, digital logic), computing (programming, database), writing (writing 1 and 2), oral communications, ethics, etc. A total of 3 units is required to satisfy the General Education: Integrative and Applied Learning requirement. *Meets the General Education Requirement: Integrative and Applied Learning.*
Prerequisite: Sophomore standing in the engineering major, and department consent.

ENGR 495, Topics in Engineering, 1-3 Units

This course presents timely and new topics in engineering. Different material is covered each time the course is offered. The course may be repeated for credit. Most topics require prerequisites, which vary according to the topic.
Prerequisite: Department consent

ENGR 496, Writing 3: Engineering Management, Economics, and Ethics, 3 Units

This course covers engineering program management, economics, and ethics fundamentals; topics include program planning, control strategies, risk assessment, work breakdown structures, and costing options, including their economic and ethical implications. Assignments include instruction in professional writing for the field of engineering as students read about technical writing and complete multiple writing exercises on the topics of engineering management, economics, and ethics. Interaction with other students in the process of writing, revising, editing, and proofreading is an integral part of the course. Over the course of the semester, each student builds a portfolio through the various writing assignments. *Meets the General Education Requirement: Writing 3: Writing in the Disciplines.*
Prerequisite: Senior standing in the engineering major and a C- or better in Writing 2.

MATH 90, Foundations of Mathematical Reasoning, 3 Units

This course prepares students for MATH 95 Intermediate Algebra, MATH 115 Mathematics in Society, or MATH 130 Introduction to Statistics. Topics include proportional reasoning; financial decision making; chance, risk, and probability; and algebraic modeling. Students practice reading, analyzing, and writing about quantitative texts; using spreadsheets to make efficient calculations; and solving algebraic equations to make predictions and decisions. This course does not meet the General Education Quantitative Literacy requirement and does not count toward total units needed for graduation.
Prerequisite: An appropriate score on the APU mathematics placement assessment.

MATH 95, Intermediate Algebra, 3 Units

This course prepares students for the General Education Quantitative Literacy courses. Topics include linear graphs, mathematical models, systems of equations in two and three variables, multiplying and factoring polynomial functions, rational and radical expressions and functions, complex numbers, quadratic equations, and mathematical modeling with quadratic functions. This course does not meet the General Education Quantitative Literacy requirement and does not count toward total units needed for graduation.
Prerequisite: MATH 90 or an appropriate score on the APU mathematics placement assessment

MATH 99, Self-paced Mathematics Lab, 1 Unit

This course is an alternative to MATH 90 for students who prefer an individualized developmental math experience. An adaptive online learning system enables students to skip topics they have already mastered and work at their own pace on the topics they need to learn, with support from a faculty member. The goal is to help students test out of MATH 90 in order to accelerate their path toward a General Education Quantitative Literacy course. This course does not meet the General Education Quantitative Literacy requirement and does not count toward total units needed for graduation.
Prerequisite: ALEKS math placement score of 0-29 (or no ALEKS score).

MATH 110, College Algebra, 3 Units

This course offers a study of basic college algebra, including various elementary functions (linear, polynomial, rational, radical, exponential, and logarithmic), their properties and graphs, and equations and systems of equations. Emphasis is on using algebraic concepts to model and analyze real-world phenomena. *Meets the General Education Requirement: Quantitative Literacy (Math).*
Prerequisite: MATH 95 or an appropriate score on the APU mathematics placement assessment.

MATH 115, Mathematics in Society, 3 Units

This course helps students make sense of quantitative information commonly encountered in everyday life in society. Students use mathematical methods and spreadsheets to analyze data from real newspaper articles in order to deepen their understanding of societal issues and personal financial management. Mathematical topics include estimation, unit conversions, percentages, indices, weighted averages, statistical summaries, linear and exponential models, and probabilities. These tools are used to analyze issues such as carbon footprints, crime rates, currency conversions, taxes, minimum wages, inflation, grade-point averages, salary distributions, electricity bills, climate change predictions, interest and depreciation, gambling, insurance, screening for diseases, and DNA evidence. *Meets the General Education Requirement: Quantitative Literacy (Math).*
Prerequisite: MATH 90 or an appropriate score on the APU mathematics placement assessment.

MATH 130, Introduction to Statistics, 3 Units

This course is an introduction to the basic concepts and practices of statistics, including frequency distributions; graphs; central tendency; variation; probability; binomial, normal, t, and chi-square distributions; confidence intervals; hypothesis testing; correlation; regression; and ANOVA. *Meets the General Education Requirement: Quantitative Literacy (Math).*
Prerequisite: MATH 90 or an appropriate score on the APU mathematics placement assessment.

MATH 149, Fundamentals of Precalculus, 1 Unit

This course is a condensed alternative to MATH 150 designed for biology, biochemistry, and chemistry majors. Topics include circle trigonometry and sinusoidal functions, right-triangle trigonometry, and trigonometric equations and identities, as well as a brief review of exponential and logarithmic equations.
Prerequisite: MATH 110 or an appropriate score on the APU mathematics placement assessment. Only students with a declared major or interest in biology, biochemistry, or chemistry are permitted to register for this class.

MATH 150, Precalculus, 3 Units

This course prepares students for the calculus sequence. Topics include number systems, analytic geometry, elementary function theory (including logarithmic and trigonometric functions), and basic proof techniques.
Prerequisite: MATH 110 or an appropriate score on the APU mathematics placement assessment

MATH 151, Applied Calculus I, 3 Units

This course is an introduction to the calculus of a single variable, with a focus on applications. Topics include elementary functions (linear, exponential, logarithmic, power, and periodic), differentiation, and optimization.
Prerequisite: B- or better in MATH 110, or an appropriate score on the APU mathematics placement assessment.

MATH 165, Calculus I, 3 Units

Students in this course learn the theory and applications of the derivative, a mathematical tool used to calculate instantaneous rates of change. Topics include limits, continuity, interpretation and computation of derivatives, shapes of graphs, optimization, related rates, and parametric equations.
Prerequisite: MATH 150 or an appropriate score on the APU mathematics placement assessment or MATH 149 (May be taken concurrently)

MATH 166, Calculus II, 3 Units

Students in this course learn the theory and applications of the integral, a mathematical tool used to calculate the net change in a quantity over time. Topics include the definite integral, antiderivatives, the Fundamental Theorem of Calculus, integration techniques and applications, area and volume, arc length and surface area, and polar coordinates. The course concludes with a brief introduction to differential equations.
Prerequisite: C- or better in MATH 165

MATH 167, Sequences and Series, 1 Unit

This course introduces the powerful method of representing a function as a "polynomial of infinite degree." Topics include sequences and series, tests for convergence, power series, intervals of convergence, Taylor series, and applications.
Prerequisite: MATH 166 (May be taken concurrently)

MATH 199, Calculus Fundamentals for Statistics, 1 Unit

This course introduces fundamental topics in calculus required for understanding statistical theory and methods, including the interpretation of derivatives and integrals, rules for single-variable differentiation and integration, applications to optimization, moments and areas, and basic multivariable differentiation and integration.
Prerequisite: Acceptance into M.S. in Applied Statistics and Analytics program.

MATH 201, Mathematics Concepts for Elementary Teachers, 3 Units

The course provides the foundations of modern mathematics needed by the elementary school teacher. It is not a methods course, but a prerequisite to the Multiple-Subject Teaching Credential Program. This course does not count toward a mathematics major or minor.
Prerequisite: MATH 110 or equivalent

MATH 250, Data Analysis, 3 Units

This course features hands-on experience using statistical tools to answer real-world questions. Emphasis is on analysis of actual data using statistical software. Statistical topics include numerical/graphical summaries, measures of association, and statistical techniques including chi-square tests, t-tests, ANOVA, and regression. Focus is on interpretation, not calculation.
Prerequisite: MATH 130 or MATH 361

MATH 268, Multivariable Calculus, 3 Units

Students in this course learn about the calculus of functions of several variables. Topics include surfaces and contour diagrams, vectors, partial and directional derivatives, optimization and Lagrange multipliers, and multiple integration in rectangular, polar, cylindrical, and spherical coordinate systems.
Prerequisite: C- or better in MATH 166

MATH 269, Vector Calculus, 2 Units

Students in this course learn about the calculus of vector fields, leading to several higher-dimensional versions of the Fundamental Theorem of Calculus. Topics include parametrized curves; vector fields and flow; line integrals, gradients, and path-independence; Green's Theorem; divergence, flux integrals, and the Divergence Theorem; curl and Stokes' Theorem; and parametrized surfaces and change of coordinates.
Prerequisite: C- or better in MATH 268

MATH 270, Ordinary Differential Equations, 4 Units

This course is an introduction to ordinary differential equations and their applications. Topics include first- and second-order equations, Laplace transform, systems of differential equations, phase plane analysis, and introduction to numerical methods.
Prerequisite: MATH 268, or B- or better in MATH 166.

MATH 280, Discrete Mathematics and Proof, 3 Units

This course is a rigorous introduction to discrete mathematics with an emphasis on problem solving and proof writing, preparing students to construct valid mathematical arguments in upper-division courses. Topics include mathematical logic and set theory; direct and indirect proof; proofs with conjunctions, disjunctions, and quantifiers; relations; equivalence relations and partitions; functions and invertibility; and mathematical induction. Lecture, 3 hours; Discussion, 1 hour.
Prerequisite: MATH 165

MATH 290, Linear Algebra, 3 Units

An introduction to matrix algebra, vector spaces, and linear transformations. Topics include systems of linear equations, subspaces, linear independence, bases and dimension, abstract vector spaces, orthogonality, least-squares methods, inner product spaces, determinants, eigenvalues, and diagonalization.
Prerequisite: MATH 268 or MATH 280

MATH 295, Applied Linear Algebra, 3 Units

This course is an introduction to the analysis of numerical computations in linear algebra, including solutions of linear systems, QR decomposition, computation of eigenvalues and eigenvectors, and singular value decomposition.
Prerequisite: MATH 166

MATH 299, Linear Algebra Fundamentals for Statistics, 1 Unit

This course introduces fundamental topics in linear algebra required for statistical courses, including linear and generalized linear models, vectors and matrices, basic matrix operations, methods to solve linear systems, LU/QR decomposition, singular value decomposition, and computation of eigenvalues and eigenvectors.
Prerequisite: Acceptance into M.S. in Applied Statistics and Analytics program.

MATH 301, Mathematics for Secondary Teachers, 3 Units

A survey of the foundations of mathematics essential to the secondary school teacher. This course integrates secondary mathematics concepts with problem-solving strategies and technology. Students expand on their understanding of core math concepts, evaluate lesson plans used in secondary school mathematics, discuss and reflect on effective mathematics pedagogy, analyze readings in the field, engage in collegial interactions with the instructor and fellow students, and develop a repertoire of classroom-tested lessons that can be used in a high school classroom.

MATH 311, Teaching and Learning in STEM, 2 Units

Students in this course learn about the fundamentals of effective STEM teaching, including common challenges for STEM learners, active engagement strategies, assessment techniques, supporting diverse learners, designing assignments, and planning courses and lessons.
Prerequisite: BIOL 151, CHEM 151, CS 120, MATH 165, PHYC 155, PHYC 165, or equivalent

MATH 312, STEM Education Research Seminar, 1 Unit

Students identify challenges for effective STEM education that they observe during their experiences as STEM students and in STEM teaching support roles. Using readings drawn from the STEM education research literature, students identify and evaluate solutions to these challenges.
Prerequisite: BIOL 151, CHEM 151, CS 120, MATH 165, PHYC 155, PHYC 165, or instructor permission

MATH 313, STEM Teaching Practicum, 1 Unit

This course is intended for students serving in teaching support roles for STEM courses, including Learning Assistants, Teaching Assistants, and tutors. Students observe and reflect on effective STEM teaching practices and assist learners in engaging with and understanding course content.
Prerequisite: BIOL 151, CHEM 151, CS 120, MATH 165, PHYC 155, PHYC 165, or instructor permission

MATH 340, Geometry, 3 Units

This course is a study of Euclidean and hyperbolic geometries and their transformations and models. Students learn to write proofs within an axiomatic system and to form conjectures using interactive geometry software.
Prerequisite: MATH 166

MATH 350, Statistical Models, 3 Units

A study of investigative statistics emphasizing the process of data collection and data analysis relevant for science, social science, and mathematics students. The course incorporates case studies from current events and interdisciplinary research, taking a problem-based approach to learn how to determine which statistical techniques are appropriate. Topics include nonparametric tests, designing an experiment, multiple regression models, and Bayesian data analysis. Ethics in data analysis and reporting will be considered from a Christian perspective. Additionally, the course includes learning to program using a statistical software package.
Prerequisite: MATH 250

MATH 361, Introduction to Modeling with Probability, 3 Units

This course is an introduction to probability models used in statistics and data analysis. Topics include basic axioms of probability, random variables, probability distributions, expected values, and probability distribution theory.
Prerequisite: MATH 166

MATH 362, Mathematical Statistics, 3 Units

This course is an introduction to descriptive and inferential statistics used in data analysis. Topics include random sampling, parameter estimation, hypothesis testing and goodness of fit, summarizing data, and comparing samples.
Prerequisite: MATH 361 or STAT 501

MATH 370, Partial Differential Equations, 3 Units

This course is an introduction to Fourier analysis and analytical techniques for solving partial differential equations, with application to physical phenomena.
Prerequisite: MATH 270

MATH 375, Dynamical Systems, 3 Units

An introduction to phase plane analysis of first order differential equations and to bifurcations in continuous and discrete systems, with application to various branches of science.
Prerequisite: MATH 270

MATH 390, Number Theory, 3 Units

A study of elementary number theory, with an overview of the history of mathematics. Number theory topics include primes, divisibility, factorization, Diophantine problems, residue systems, theorems of Fermat and Euler, and continued fractions.
Prerequisite: MATH 280

MATH 400, Abstract Algebra, 3 Units

An introduction to groups and rings. Group theory topics include subgroups, cyclic groups, permutation groups, cosets and normal subgroups, factor groups, and homomorphisms. Ring theory topics include subrings and ideals, integral domains and fields, factor rings, and homomorphisms.
Prerequisite: MATH 280 with a C- or better

MATH 450, Real Analysis, 3 Units

This course is an advanced study of the real number system. Topics include completeness, convergence of sequences and series, topology of the real line, continuity, the Intermediate Value Theorem, differentiation, and the Mean Value Theorem.
Prerequisite: MATH 167 and a C- or better in MATH 280

MATH 451, Data Visualization, 3 Units

This course introduces students to the field of data visualization. Students learn basic visualization design and evaluation principles, and how to acquire, parse, and analyze data sets using various data visualization software tools. Data types covered include multivariate, temporal, text-based, geospatial, and network/graph-based.
Prerequisite: MATH 130 or MATH 361

MATH 455, Numerical Analysis, 3 Units

This course covers numerical and approximation methods, including solutions of functions in single and multi-variables, interpolation, numerical differentiation and integration, and numerical methods for differential equations. Applications are programmed using an appropriate language.
Prerequisite: MATH 295 and CS 120

MATH 460, Topology, 3 Units

An introduction to topological spaces and their applications. Topics include bases, interior closure, subspace, product, and quotient topologies, continuity and homeomorphisms, metric spaces, connectedness, and compactness, with application to genetics, geography, robotics, and error-correcting codes. Additional topics chosen from homotopy theory, knot theory, and compact surfaces.
Prerequisite: MATH 450

MATH 470, Complex Analysis, 3 Units

This course is an introduction to the calculus of functions of one complex variable. Topics include elementary functions, limits, differentiability, series, contour integrals, Cauchy's theorem, conformal mapping, and selected applications.
Prerequisite: MATH 167 and MATH 268

MATH 480, Writing 3: Mathematical Reading, Writing, and Presentation, 3 Units

In this seminar course, students critically analyze journal articles in the field, receive writing instruction, write research and argumentative papers, and prepare effective mathematical presentations. *Meets the General Education Requirement: Writing 3: Writing in the Disciplines.*
Prerequisite: Junior or senior standing, Writing 2.

MATH 492, Ethics in Data Analytics, 2 Units

The availability and use of data has led to tremendous opportunities. Businesses mine data to gain a competitive advantage, and healthcare organizations use it to help improve medical decision making. The use of data, however, has led to potential abuses. This course explores ethical issues in big data analytics, including issues surrounding collection, use, and reporting of data, and considers them from a Christian worldview.

MATH 495, Advanced Topics in Mathematics, 1-3 Units

This course engages students in focused study of an advanced topic which is not covered in the regular curriculum. The topic varies from semester to semester based on student interest. Possible topics include differential geometry, combinatorics, mathematical modeling, advanced linear algebra, game theory, cryptology, etc. This course may be taken more than once as the topic changes.
Prerequisite: Prerequisite(s) will vary depending upon the topic.

MATH 496, Mathematics Senior Seminar, 3 Units

In this culminating mathematics seminar, students wrestle with an outward-focused question - "How can I apply what I have learned in order to make a difference in the world?" - as well as an inward-focused question - "How can I develop the strength of character that will sustain me in living a life of mission?" Through research and reflection, students develop personal vision for how they will deploy their mathematical skills to do God's work in the world. At the same time, students engage with readings, seminar discussions, and spiritual practices that support the long-term growth of character and virtue. *Meets the General Education Requirement: Integrative and Applied Learning.*
Prerequisite: MATH 250, MATH 480 (waived for Honors College students), and senior standing.

MATH 497, Readings, 1-4 Units

This is a program of study concentrating on assigned readings, discussions, and writing arranged between and designed by a student of upper-division standing and a full-time professor. An independent study fee is assessed for each enrollment in this class.

MATH 498, Directed Research, 1-4 Units

This course provides instruction in research design and technique, and gives students experience in the research process. The 1-unit expectation encompasses no fewer than 30 hours of work with accompanying reading, log, writing, and seminar presentation within the department or in a university research symposium. No more than 1 unit may be used to fulfill preparatory readings requirement. An independent study fee is assessed for each enrollment in this class.
Prerequisite: Junior or Senior Standing

MATH 499, Thesis/Project, 1-4 Units

This is a senior-level "capstone" type of independent study/research experience, involving the student in a unique project with a sophisticated level of research, synthesis, analysis, and communication. The 1-unit expectation encompasses no fewer than 30 hours of work with accompanying readings, log, instructor discussions, and writing of summary analysis and conclusions. The thesis or project may result in formal thesis, published article, or electronic media. No more than 1 unit may be used to fulfill preparatory readings requirement. An independent study fee is assessed for each enrollment in this class.
Prerequisite: Upper-division writing intensive course or instructor consent; and junior or senior standing

PRMA 90, Foundations of Mathematical Reasoning, 3 Units

This course prepares students for Intermediate Algebra, Mathematics in Society, or Introduction to Statistics. Topics include proportional reasoning; experimental design; graphical, tabular, and numerical presentations of data; chance, risk, and probability; and algebraic modeling. Students practice displaying, summarizing, and analyzing data; computing and interpreting probabilities; and solving algebraic equations to make predictions and decisions. This course does not meet the General Education Quantitative Literacy requirement and does not count toward total units needed for graduation.

PRMA 110, College Algebra, 3 Units

This course offers a study of basic college algebra, including various elementary functions (linear, polynomial, rational, radical, exponential, and logarithmic), their properties and graphs, and equations and systems of equations. Emphasis is on using algebraic concepts to model and analyze real-world phenomena. *Meets the General Education Requirement: Quantitative Literacy (Math).*
Prerequisite: MATH 95 or an appropriate score on the APU mathematics placement assessment.

PRMA 130, Introduction to Statistics, 3 Units

This course is an introduction to the basic concepts and practices of statistics, including frequency distributions; graphs; central tendency; variation; probability; binomial, normal, t, and chi-square distributions; confidence intervals; hypothesis testing; correlation; regression; and ANOVA. *Meets the General Education Requirement: Quantitative Literacy (Math).*
Prerequisite: MATH 90 or an appropriate score on the APU mathematics placement assessment.

PHYC 112, Science and Technology for Everyday Applications, 4 Units

This course is a nonmathematical introduction to everyday science and technologies that have drastically changed the world and impacted modern life. Despite their apparent complexity, these technologies can be understood from basic physical principles. Students in this course also examine topics of current interest such as climate change, environmental stewardship, and scientific methods. This course does not carry credit toward a science major or minor. *Meets the General Education Requirement: Civic Knowledge and Engagement, Natural Science.*
Special Fee Applies

PHYC 115, Physical Science for Teachers, 3 Units

This course focuses on three fundamental concepts of physics: conservation of energy, Newton's laws, and waves. Students will engage in practices of science such as performing experiments, collecting and analyzing data, developing models, and writing and evaluating explanations. Students will also examine the nature of science and learning. Course content is aligned with content, practices, and cross-cutting concepts of the Next Generation Science Standards. This course is intended for Liberal Studies majors and does not meet the APU General Education requirement in Natural Science.

PHYC 125, Earth Science Concepts and Applications, 3 Units

This course surveys Earth both inside and out. Topics investigated include Earth's solid surface and interior, the oceans, and Earth's atmosphere and weather patterns. Emphasis is placed on dynamic processes, including human activity that affects the nature of Earth's surface. Students also explore Earth's place in the solar system, the Sun, the stars, and exotic bodies beyond the solar system. Does not meet the APU General Education requirement in Nature.

PHYC 145, Physics Laboratory I, 1 Unit

This lab course is a companion to PHYC 155 or PHYC 165. Students in this lab course are introduced to scientific thinking skills including designing experiments, analyzing data, comparing measurements, and testing theoretical models. Experimenters answer research questions using data they obtain. Experimental topics are drawn from mechanics. Completion of this course and PHYC 155 or PHYC 165 *meets the General Education Natural Sciences requirement.*
Corequisite: PHYC 155 or PHYC 165

PHYC 146, Physics Laboratory II, 1 Unit

This lab course is a companion to PHYC 156 or PHYC 166. Students in this course are introduced to scientific thinking skills including designing experiments, analyzing data, comparing measurements, and testing theoretical models. Experimenters answer research questions using data they obtain. Experimental topics are drawn from electricity, magnetism, thermodynamics, and waves.
Prerequisite: PHYC 145. Concurrent enrollment in PHYC 156 or PHYC 166 is recommended.

PHYC 147, Physics Laboratory III, 1 Unit

In this lab course, students develop scientific thinking skills by comprehensively developing an experiment on introductory physics topics, including proposing a research question, designing experiments, analyzing data, comparing measurements, and testing theoretical models. Experimenters answer research questions using data they obtain.
Special Fee Applies
Prerequisite: PHYC 146

PHYC 155, Physics for Life Sciences I, 3 Units

Students in this noncalculus physics course study translational and rotational mechanics and begin to explore thermodynamics. *Meets the General Education Requirement: Natural Science.*
Prerequisite: MATH 110 or equivalent score on APU mathematics placement assessment; high school geometry and trigonometry highly recommended.

PHYC 156, Physics for Life Sciences II, 3 Units

Students in this noncalculus physics course explore the topics of waves, sound, light, electricity and magnetism, quantum theory, and structure of matter.
Prerequisite: PHYC 155

PHYC 165, Physics for Science and Engineering: Mechanics, 4 Units

Students in this course explore various areas of physics using basic differential and integral calculus. Topics include kinematics, Newton's laws, conservation of energy, conservation of momentum, and rotation. *Meets the General Education Requirement: Natural Science.*
Corequisite: MATH 165 or equivalent calculus background; high school physics or university-level conceptual physics strongly recommended.

PHYC 166, Physics for Science and Engineering: Electricity and Magnetism, 4 Units

Students are introduced to the various areas of physics using basic differential and integral calculus. Topics include electricity, circuits, magnetism, and modern physics.
Prerequisite: PHYC 165 and MATH 166 (may be taken concurrently)

PHYC 167, Physics for Science and Engineering: Relativity, 1 Unit

Students are introduced to the various areas of physics using basic differential and integral calculus. This course focuses on Einstein's theory of special relativity, including frames of reference, spacetime diagrams, Lorentz transformations, and mass-energy equivalence.
Prerequisite: MATH 110, MATH 150, or MATH 165

PHYC 168, Physics for Science and Engineering: Waves and Thermodynamics, 3 Units

Students are introduced to the various areas of physics using basic differential and integral calculus. Topics covered include oscillations, waves, and thermodynamics.
Prerequisite: PHYC 155 or PHYC 165

PHYC 300, Physics Research Seminar, 1 Unit

This course surveys the major fields of modern physics research in a seminar format, with special attention to how physicists identify research questions and plan for research. The course culminates in a research proposal for the student's thesis. *Meets the General Education Requirement: Integ Applied Learning (PHYC 300 + PHYC499).*
Prerequisite: PHYC 168

PHYC 311, Teaching and Learning in STEM, 2 Units

Students in this course learn about the fundamentals of effective STEM teaching, including common challenges for STEM learners, active engagement strategies, assessment techniques, supporting diverse learners, designing assignments, and planning courses and lessons.
Prerequisite: BIOL 151, CHEM 151, CS 120, MATH 165, PHYC 155, PHYC 165, or equivalent

PHYC 312, STEM Education Research Seminar, 1 Unit

Students identify challenges for effective STEM education that they observe during their experiences as STEM students and in STEM teaching support roles. Using readings drawn from the STEM education research literature, students identify and evaluate solutions to these challenges.
Prerequisite: BIOL 151, CHEM 151, CS 120, MATH 165, PHYC 155, PHYC 165, or instructor permission

PHYC 313, STEM Teaching Practicum, 1 Unit

This course is intended for students serving in teaching support roles for STEM courses, including Learning Assistants, Teaching Assistants, and tutors. Students observe and reflect on effective STEM teaching practices and assist learners in engaging with and understanding course content.
Prerequisite: BIOL 151, CHEM 151, CS 120, MATH 165, PHYC 155, PHYC 165, or instructor permission

PHYC 361, Electricity and Magnetism, 3 Units

Students in this course study the fundamental concepts of electricity and magnetism, electrostatic fields in a vacuum and dielectric materials, solutions of the Laplace and Poisson equations, and electromagnetic waves.
Prerequisite: PHYC 166, MATH 268, and MATH 269

PHYC 370, Waves and Optics, 3 Units

Students in this course study mechanical and electromagnetic waves and explore topics such as geometric optics, wave propagation, interference, diffraction, polarization, coherence, and holography, as well as topics from nonlinear optics.
Prerequisite: PHYC 168, MATH 268, and MATH 270 (may be taken concurrently).

PHYC 380, Classical Mechanics, 4 Units

Students in this course apply mathematical methods commonly used in physics modeling and analysis to the study of particles experiencing linear and quadratic drag, momentum, energy, driven oscillations, central force motion, rigid-body rotation, and Lagrangian dynamics. The mathematical methods used include infinite series, complex numbers, linear algebra, curvilinear coordinates, vector calculus, Fourier analysis, partial differential equations, variational calculus, and numerical methods.
Prerequisite: PHYC 165, MATH 167, MATH 268, and MATH 270

PHYC 401, Thermodynamics, 3 Units

Students in this course learn the theoretical basis of classical thermodynamics and statistical mechanics including the zeroth, first, second, and third laws. These laws are applied to equilibrium systems such as ideal gases, heat engines, chemical reactions, and phase transitions.
Prerequisite: PHYC 168 and MATH 268 (may be taken concurrently)

PHYC 431, Computational Methods for Physics, 3 Units

Students in this course develop numerical modeling skills to solve representative problems in mechanics, quantum mechanics, thermal physics, and electromagnetism. The problems solved include multibody dynamics under gravity, Laplace's equation, the wave equation, the Ising model, the time-independent Schrodinger equation, and molecular dynamics.
Prerequisite: CS 120, MATH 268, MATH 270

PHYC 440, Quantum Mechanics, 3 Units

Students are introduced to the time-dependent and time-independent Schrodinger equations. The Schrodinger equation is solved for examples including potential wells and barriers, harmonic oscillators, and hydrogen atoms. These examples illustrate the concepts of quantization of energy and angular momentum, tunneling, wave properties of particles, and the uncertainty principle.
Prerequisite: MATH 270 and PHYC 370, or instructor consent

PHYC 470, Writing 3: Advanced Laboratory, 3 Units

This course prepares students for writing scientific journal articles and presenting scientific results to a technical audience. This course also acquaints students with advanced laboratory and analysis techniques. Activities include instruction and practice in scientific writing and presenting scientific information orally. *Meets the General Education Requirement: Writing 3: Writing in the Disciplines.*
Special Fee Applies
Prerequisite: PHYC 168, Writing 2, and junior or senior standing or instructor's consent.

PHYC 497, Readings, 1-4 Units

This is a program of study concentrating on assigned readings, discussions, and writing arranged between and designed by a student of upper-division standing and a full-time professor. An independent study fee is assessed for each enrollment in this class.

PHYC 498, Directed Research, 1-4 Units

This course provides instruction in research design and technique, and gives students experience in the research process. The 1-unit expectation encompasses no fewer than 30 hours of work with accompanying reading, log, writing, and seminar presentation within the department or in a university research symposium. No more than 1 unit may be used to fulfill preparatory readings requirement. An independent study fee is assessed for each enrollment in this class.
Prerequisite: Junior or Senior Standing

PHYC 499, Physics Thesis, 1-4 Units

Students engage in original research projects in collaboration with a faculty member. Projects may be experimental, theoretical, or computational in nature, and projects expand upon learning from previous courses in the major and apply that learning to make a novel contribution to the field. Successful completion of the course results in completion of a journal-style article and/or professional-level poster presentation. *Meets the General Education Requirement: Integ Applied Learning (PHYC 300 + PHYC499).*
Prerequisite: PHYC 300

PRPY 112, Science and Technology for Everyday Applications, 4 Units

This course is a nonmathematical introduction to everyday science and technologies that have drastically changed the world and impacted modern life. Despite their apparent complexity, these technologies can be understood from basic physical principles. Students in this course also examine topics of current interest such as climate change, environmental stewardship, and scientific methods. This course does not carry credit toward a science major or minor. *Meets the General Education Requirement: Natural Science, Civic Knowledge and Engagement.*
Special Fee Applies

PRPY 125, Earth Science Concepts and Applications, 3 Units

This course surveys Earth both inside and out. Topics investigated include Earth's solid surface and interior, the oceans, and Earth's atmosphere and weather patterns. Emphasis is placed on dynamic processes, including human activity that affects the nature of Earth's surface. Students also explore Earth's place in the solar system, the Sun, the stars, and exotic bodies beyond the solar system. Does not meet the APU General Education requirement in Nature.

STAT 501, Introduction to Modeling with Probability, 3 Units

This course is an introduction to probability models used in statistics and data analysis. Topics include basic axioms of probability, random variables, probability distributions, expected values, and probability distribution theory.
Prerequisite: Calculus (multivariable preferred) and linear algebra; students who are lacking in one area or the other may satisfy the prerequisite by passing MATH 199 and/or MATH 299.

STAT 502, Mathematical Statistics, 3 Units

This course offers an introduction to descriptive and inferential statistics used in data analysis. Topics include random sampling, parameter estimation, hypothesis testing and goodness of fit, summarizing data, and comparing samples.
Prerequisite: STAT 501

STAT 511, Applied Regression Analysis, 3 Units

This course is an introduction to simple and multiple linear regression models. Topics include parameter estimation, diagnostics, model selection, prediction, and models with categorical predictors.
Prerequisite: STAT 501;
Corequisite: STAT 502

STAT 512, Analysis of Variance and Design of Experiments, 3 Units

This course offers an introduction to designing and analyzing data using experiments. Basic experimental designs are covered, including block, factorial, and fractional factorial. Analysis of Variance (ANOVA) models and their assumptions, estimation, and interpretation are introduced. Statistical software is used for all analysis.
Prerequisite: STAT 501;
Corequisites: STAT 502, STAT 511

STAT 521, Statistical Computing and Programming, 3 Units

Students in this course gain basic familiarity with SAS and R programming for data management and analysis. The course takes place in a computer lab, enabling students to implement the lecture material as it is presented. Assignments require using SAS and R to perform data management techniques, generate descriptive statistics and graphical representations of data, and apply statistical methods available in software.
Prerequisite: MATH 361 or equivalent

STAT 541, Epidemiology Research Methods, 3 Units

The purpose of this course is to equip students with the basic concepts and principles of epidemiology, a discipline that identifies the determinants of disease in human populations and assesses the magnitude of public health problems and the success of interventions designed to control them. Students learn about various epidemiologic study designs and their strengths and limitations, the basic mathematical tools needed in epidemiology, the collection of epidemiologic data, and the criteria of causality. Also, the course addresses the biases that may invalidate epidemiologic studies, and considers ethical concerns in epidemiology from a Christian faith perspective.

STAT 542, Applied Logistic Regression and Survival Analysis, 3 Units

This course offers an introduction to methods for analyzing binary outcome and time-to-event data, with the primary focus on how to analyze such data using methods available in standard statistical software packages. Topics include logistic regression estimation, interpretation, and assessment. For time-to-event data, summary statistics for censored data, nonparametric methods (specifically Kaplan-Meier), and semiparametric regression methods centered on the Cox model are introduced.
Prerequisite: STAT 511 and STAT 521 or equivalent

STAT 543, Advanced Modeling for Data Science, 3 Units

This course introduces advanced modeling approaches in data science, focused on classical and modern approaches to analyzing continuous and discrete longitudinal data. Topics include exploratory analysis of correlated data, data visualization, generalized linear models, random effects models, Generalized Estimating Equations (GEE), analysis of discrete longitudinal data, and statistical analysis with missing data. Emphasis is on estimation using statistical software and model interpretation.
Prerequisite: STAT 511 and STAT 521 or equivalent

STAT 551, Data Visualization, 3 Units

This course introduces students to the field of data visualization. Students learn basic visualization design and evaluation principles, and also how to acquire, parse, and analyze data sets using various data visualization software tools. Data types included in the course include multivariate, temporal, text-based, geospatial, and network/graph-based.
Prerequisite: B- or better in MATH 295 and MATH 361, or admission to graduate school.

STAT 552, Time Series Analysis and Forecasting, 3 Units

In this course, students develop a working knowledge of time series analysis and forecasting methods, with a focus on applications. Topics include descriptive analysis, probability models for time series, fitting and forecasting for time series models, bootstrapping, models for nonstationary series, and an introduction to spectral analysis.
Prerequisite: STAT 502 and STAT 521

STAT 553, Data Mining, 3 Units

Data mining focuses on algorithms and computational paradigms that allow computers to find patterns and regularities in data in order to perform prediction or find structure and relationships to help improve decision making. This course covers basic methodology, major software tools, and applications in data mining. Students learn conceptual underpinnings of methods in data mining while focusing more on usage of existing software packages than developing the algorithms. In particular, the course covers the methodology, motivation, assumptions, strengths, and weaknesses of the most widely applicable methods in the field.
Prerequisite: STAT 511 or STAT 521 or STAT 551 or PSYC 518

STAT 571, Applied Multivariate Analysis, 3 Units

This course introduces a variety of standard statistical methods used to analyze multivariate data, emphasizing the implementation and interpretations of the methods. Topics covered include matrix computation of summary statistics, graphical techniques, the geometry of sample data, the multivariate normal distribution, principal components analysis, factor analysis, classification and discrimination, and cluster analysis.
Prerequisite: STAT 511 and STAT 521

STAT 572, Applied Bayesian Analysis, 3 Units

This course provides a practical introduction to Bayesian data analysis. Students are exposed to a variety of Bayesian models, including the Bayesian linear model and Bayesian hierarchical modeling as a strategy for modeling complex processes and as a means of assimilating a variety of sources of data. Models are fit for various types of data using modern simulation techniques in statistical software. The focus of the course is modeling, assessing model appropriateness, and interpretation.
Prerequisite: STAT 511 and STAT 521

STAT 573, Applied Nonparametric Statistics, 3 Units

This course provides an overview of nonparametric statistics, helping students learn the difference between parametric and nonparametric statistics and when each is appropriate. This course includes the basic theory and computing tools to perform traditional rank-based nonparametric tests, and advanced topics include nonparametric density estimation, nonparametric regression, and the bootstrap.
Prerequisite: STAT 511 and STAT 521

STAT 574, Discrete Data Analysis, 3 Units

This course covers basic methods for analysis of discrete data, including methods for analyzing and describing discrete data in contingency tables, and statistical models for discrete outcomes that are binary, counts, nominal, and ordinal. Emphasis is on using statistical software to fit models to data, assessing the appropriateness, and interpreting the results in context.
Prerequisite: STAT 511 and STAT 521

STAT 575, Applied Survey Sampling, 3 Units

This course covers sampling design and analysis methods useful for research and management in many fields. Students learn about the basic methods of sampling and estimation and then explore selected designs and recent developments. Topics include simple random sampling with associated estimation and confidence interval methods, selecting sample sizes, estimating proportions, unequal probability sampling, ratio and regression estimation, stratified sampling, cluster, systematic sampling, multistage designs, and double sampling.
Prerequisite: STAT 502 and STAT 521

STAT 592, Ethics in Data Analytics, 2 Units

The availability and use of data has led to tremendous opportunities. Businesses mine data to gain a competitive advantage, and healthcare organizations use it to help improve medical decision making. The use of data, however, has led to potential abuses. This course explores ethical issues in big data analytics, including issues surrounding collection, use, and reporting of data, and considers them from a Christian worldview.

STAT 595, Special Topics in Applied Statistics, 3 Units

This course presents coverage of topics in applied statistics.
Prerequisite: Based upon the topic offered.

STAT 596, Practicum, 0-1 Units

In this course - the practicum course of the Master of Science in Applied Statistics and Analytics program - students collaborate with professionals in academic or industry organizations to develop professional experience.
Prerequisite: Instructor permission required

STAT 597, Statistical Consulting Practicum, 4 Units

Students in this course investigate the role of the statistician as consultant and collaborator. Topics include problem solving and communication skills (oral and written), structuring working engagements with nonstatisticians and collaborators, and skills specific to statistical consulting. Case studies or ongoing projects are used to provide hands-on consulting experience. Students identify, and produce their proposal for, their culminating project during this course.
Prerequisite: STAT 511 and STAT 521

STAT 598, Culminating Project, 4 Units

This is the capstone course of the Master of Science in Applied Statistics and Analytics program. It is open to second-year students in good standing. Students provide an oral presentation and a written report of the project.
Prerequisite: STAT 597

STAT 599, Independent Study, 1-3 Units