CHEM 227 Organic Chemistry I **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): CHEM 130

Organic Chemistry I provides a comprehensive introduction to the chemistry of carbon compounds. It covers aliphatic and aromatic compounds, stressing modern theory and stereochemistry to illustrate the logic and predictability of chemical transformations. It includes general principles and their applications in various industrial and biological processes, with an emphasis on the energy and mechanisms of reactions, synthesis, and the structure of organic molecules.

CHEM 228 Organic Chemistry II **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): CHEM 227

Organic Chemistry II extends the scope of Organic Chemistry I by delving into the chemistry of various functional groups, utilizing theory to unify and clarify diverse chemical transformations and introducing qualitative organic analysis with a focus on spectroscopic methods.

CHEM 237 Organic Chemistry I Laboratory **1 Credit**
Grade Mode: Standard Letter

Organic Chemistry Laboratory I covers elementary and advanced laboratory techniques, including the preparation, reactions, purification, and properties of representative organic compounds. It introduces synthesis and purification methods for specific compounds discussed in lectures, and qualitative organic analysis.

CHEM 238 Organic Chemistry II Laboratory **1 Credit**
Grade Mode: Standard Letter

A major portion of this laboratory course is devoted to methods employed in organic qualitative analysis. The student is expected to identify several unknown compounds and mixtures.

Chemical Engineering

CHEN 201 Chemical Engineering Foundation **2 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): ENGR 110 and MATH 161

This course introduces fundamental concepts in engineering, including accounting principles, basic statistics, and dynamics of systems. Students will gain skills in using Excel for data analysis, enhance their problem-solving abilities, and learn the basics of engineering graphics, preparing them for practical applications.

CHEN 204 Elementary Chemical Engineering **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): CHEM 130 and PHYS 216

This course focuses on application of mass balances, energy balances, and equilibrium concepts for solution of elementary problems related to chemical processes.

CHEN 205 Thermodynamic I **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): CHEN 204

This course explores the fundamental principles of thermodynamics through the lens of chemical processes. It covers the core concepts including the basic laws of thermodynamics, properties of single-component systems, fluid expansion and compression, and the operation of heat engines.

CHEN 304 Fluid Mechanics **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): MATH 318 and CHEN 205, CHEN 204; MATH 318; CHEN 205 or concurrent enrollment

This course provides students with a foundational understanding of fluid mechanics principles essential for process equipment design and analysis. Students will explore the fundamental concepts of fluid behavior and their relevance to engineering design in various industrial settings, with emphasis on applying fluid mechanics principles to the analysis and optimization of process equipment, including pumps, pipes, and valves. Prerequisites: CHEN 204; MATH 318; CHEN 205 or concurrent enrollment.

CHEN 320 Numerical Methods in Chemical Engineering **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): CHEN 204 and MATH 318

Applications of numerical analysis techniques to mathematical models of processes common to chemical and associated industries; computational methods and software for analysis of chemical engineering processes.

CHEN 322 Materials Engineering **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): MATH 262

Overview of materials science with particular emphasis on classes of materials relevant to chemical engineers.

CHEN 323 Heat Transfer **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): CHEN 304

Heat transfer principles in conduction, convection, radiation and their practical applications within chemical engineering with emphasis on heat exchangers, covering design methodologies, performance evaluation, and optimization techniques.

CHEN 324 Mass Transfer **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): CHEN 354

Fundamental of diffusion and convective mass transfer and their applications to design and analysis of separation processes equipment, including distillation columns, absorber, membranes, and liquid-liquid extraction.

CHEN 354 Thermodynamics II **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): CHEN 205

This course focuses on applying thermodynamic principles to the analysis of pure and mixed fluids and phase and chemical reaction equilibria. It blends theoretical concepts with real-world examples to explore the behavior of fluids and chemical systems under different thermodynamic conditions.

CHEN 364 Reaction Kinetics and Reactor Design **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): CHEN 320

Analysis of reaction kinetics and the practical application of fundamental principles in designing and operating of batch and continuous reactor. Effect of heat and mass transfer on reactor design.

CHEN 368 Physical Chemistry for Chemical Engineering **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): CHEM 130 and CHEN 354

This course provides chemical engineering students with a foundational understanding of physical chemistry principles essential for engineering applications. Through a combination of theoretical concepts and practical examples, students will delve into key areas including quantum theory, spectroscopy, statistical mechanics, kinetic theory, reaction kinetics, electrochemistry, and macromolecules. Emphasis will be placed on connecting these principles to real-world engineering problems and applications.

CHEN 381 Seminar **1 Credit**
Grade Mode: Standard Letter
Prerequisite(s): ENGL 220, Grade of C or better in CHEN 205 and ENGL 210; grade of C or better in CHEN 304 or current enrollment; junior classification in chemical engineering

Preparation of oral and written reports on selected topics from recent technical publications, done in the context of consideration of the ethical ramifications of engineering decisions. Prerequisites: Grade of C or better in CHEN 205 and ENGL 210; grade of C or better in CHEN 304 or current enrollment; junior classification in chemical engineering.

CHEN 391 Internship **0 Credits**
Grade Mode: Pass/Non Pass

Participation in an approved high-impact learning practice, such as engaging with industry, research entities, or startup companies.

CHEN 425 Process Optimization and Economics **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): CHEN 320 and CHEN 323 and CHEN 324

Integration, simulation, and economic methods involved in the design of chemical processes and equipment. Process and energy integration applications will be performed using Aspen Plus simulation and its use in performing optimization studies. The economic analysis package in Aspen Plus will be applied to the designed processes.

CHEN 426 Plant Design **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): CHEN 322 and CHEN 425 and CHEN 364

Integration of material from other chemical engineering courses with applications to the design of plants and processes representative of the chemical and related process industries. A process plant production application will be assigned to student teams to perform material and energy balances, equipment sizing and design, an environmental impact and safety risk analysis, and finally a technoeconomic.

CHEN 432 Unit Operation Laboratory I **2 Credits**
Grade Mode: Standard Letter
Prerequisite(s): CHEN 323 and ENGL 220

Laboratory work based on the fluid mechanics and heat transfer courses.

CHEN 433 Unit Operation Laboratory II **2 Credits**
Grade Mode: Standard Letter
Prerequisite(s): CHEN 324 and CHEN 364 and ENGL 220

Laboratory sessions focus on practical applications of mass transfer, kinetics, reactor design, and process control, providing hands-on experience in these critical areas of chemical engineering.

CHEN 451 Renewable Energy **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): CHEN 354

This course explores the fundamental principles and applications of renewable energy sources, including solar, wind, hydro, and bioenergy. Students delve into the design, operation, and optimization of renewable energy systems, while also examining their environmental and economic impacts. Through projects and case studies, students develop a comprehensive understanding of sustainable energy technologies and their role in addressing global energy challenges.

CHEN 452 Air Pollution and Climate Change **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): CHEN 364

This course focuses on the complex interplay between human activities, atmospheric processes, and environmental impacts. Students study the sources, mechanisms, and effects of air pollutants on human health, ecosystems, and climate. Through interdisciplinary approaches, including chemical kinetics, transport phenomena, and environmental modeling, students analyze strategies for air quality management and mitigation of climate change. This course equips students with the knowledge and skills to address pressing environmental challenges and develop sustainable solutions for a cleaner, healthier future.

CHEN 453 Fundamentals of Environmental Remediation Processes **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

Application of environmental chemistry, microbiology, and engineering principles for effective remediation strategies. Topics include contaminant fate and transport, bioremediation, physical and chemical treatment processes, and the regulatory frameworks governing environmental cleanup efforts. It discusses environmental remediation topics including, but not limited to, using plants, microorganisms, and substrates (e.g., soil and engineered materials, nanomaterials) to address environmental contamination, including soil, water, and air remediation methods.

CHEN 455 Process Safety and Risk Analysis **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): CHEN 322 and CHEN 364

This course covers applications of chemical engineering fundamentals to process safety and hazards analysis, mitigation, and prevention with special emphasis is on chemical processes. It discusses source modeling for leakage rates, dispersion, analysis, relief valve sizing, fire and explosion damage analysis, hazards identification, risk analysis, accident investigations.

CHEN 456 Waste Management and Processing **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

Principles and practices involved in the management and processing of various types of waste, including municipal, industrial, and hazardous waste. The environmental, economic, and social implications of waste generation and the importance of sustainable waste management and valorization strategies. The fundamental concepts of waste characterization, collection, transportation, treatment, and disposal by latest technologies and techniques used in waste processing, such as resource recovery, recycling, digestion, composting, incineration, gasification, and landfill management. Regulatory frameworks and policies governing waste management, both at the local and global levels.

CHEN 457 Environmental Engineering **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): CHEN 305 and CHEN 354

This course explores core principles of environmental engineering, focusing on water and air pollution control, waste management, and sustainable practices. Students delve into chemical engineering concepts applied to environmental protection, including water treatment processes, air quality management, and solid waste disposal methods. Through lectures, discussions, and hands-on activities, students gain an understanding of environmental challenges and develop skills to design solutions for a sustainable future.

CHEN 458 Water and Wastewater Treatment Processes **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

The course delves into desalination technologies and wastewater treatment processes, covering membrane-based and thermal methods for desalination, as well as advanced physical, chemical, and biological processes for treating wastewater. It highlights the design, operation, and optimization of treatment systems, with practical lab sessions offering hands-on experience in water quality analysis and treatment techniques. Students are equipped to confront global water challenges and play a role in sustainable water resource management.

CHEN 459 Gas and Petroleum Processing **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): CHEN 324

This course explores the design and operation of petroleum and gas processing facilities. It covers various aspects such as hydrate suppression, dehydration, sweetening, sulfur recovery, and LPG and liquid recovery, as well as refining operations. Through extensive process simulation, students gain practical insights into industrial processes.

CHEN 460 Quantitative Risk Analysis in Safety Engineering **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

Analysis of major accidents in the chemical process industries. Workshop/laboratories on quantitative risk and hazard analysis methods – What-If analysis, Failure Mode and Effect, HAZOP, Event Tree, Fault Tree and MTBF, mean time between failures.

CHEN 461 Process Control **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): CHEN 320 and CHEN 364

Analysis of process dynamics and methods for the design of automatic control systems for chemical process plants. Analysis of transient behavior for process systems, and their application to feedback control loops to optimize the performance of chemical plant units. Some industrial applications of control systems will be reviewed.

CHEN 462 Machine Learning for Engineers **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): ENGR 110

This course introduces students to the principles and applications of machine learning techniques in engineering contexts. Through hands-on projects and case studies, students learn to apply algorithms such as regression, classification, clustering, and neural networks to analyze complex data sets and extract valuable insights. By the end of the course, students are equipped with the knowledge and tools to leverage machine learning for solving real-world engineering problems, including process optimization, predictive modeling, and system control.

CHEN 464 Pharmaceutical and Food Engineering **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

Processing equipment - reactors, centrifuges, mills, tablet presses - and process design. Typical operations - mixing, drying, granulation, distillation and filtration. Good manufacturing practice, validation, FDA, EMA and sterilization of equipment.

CHEN 466 Chemical Process Industry **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): CHEN 354 and CHEN 304

This course explores chemical process and related industries. It covers the historical development, operational principles, and supply chain dynamics. Emphasis is placed on technical, market, sustainability, and safety considerations to provide a comprehensive understanding of the industry landscape.

CHEN 470 Applied Catalysis **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): CHEN 364 and CHEN 354

This course covers catalysis principles, focusing on industrial applications. Topics include catalyst preparation, characterization methods, deactivation mechanisms, testing and regeneration techniques, alongside the fundamentals of heterogeneous reaction kinetics. Applications to selected industrial processes are discussed.

CHEN 472 Materials Synthesis, Characterization, and Testing **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): CHEN 322

Studying the science and engineering principles governing the production and evaluation of materials. A range of synthesis methods will be discussed, including wet chemistry/biochemistry, chemical vapor deposition, physical deposition, and additive manufacturing. Explore the analytical techniques used to characterize the structural, chemical, and physical properties of these materials such as spectroscopy, microscopy. Develop hands-on skills in testing mechanical, thermal, and chemical properties.

CHEN 474 Nanotechnology and Nanomaterials **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): CHEN 322

An exploration of nanoscale phenomena and materials, covering synthesis, characterization, and applications. Topics include quantum effects, nanofabrication techniques, and nanostructured materials. Emphasizes interdisciplinary approaches, with applications in electronics, medicine, energy, and more. Lab sessions offer hands-on experience in nanomaterial synthesis and characterization techniques. Prepares students for careers in cutting-edge industries and research fields.

CHEN 476 Polymer Science and Engineering **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

This course discusses polymer engineering essentials, covering chemistry of polymerization, molecular weight concepts, polymer structure and morphology, solution and solid-state properties of polymers, mechanical properties and viscoelasticity, polymer processing and recycling, and polymer additives, blends, and composites.

CHEN 478 Solid State Physics **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): CHEN 322

The study of solids, using solid-state chemistry, quantum mechanics, crystallography, electromagnetism, and metallurgy. Solid-state physics studies how the large-scale properties of solid materials result from their atomic-scale properties -lattice structures and bond types forming the basis of materials science. It also has direct applications in the technology of transistors and semiconductors.

CHEN 482 Bioprocess Engineering **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): CHEN 324 and CHEN 364

Application of engineering principles to the design of biocatalysts and bioprocesses with emphases on the integration of biological systems with engineering concepts for practical applications.

CHEN 489 Selected Topics in Chemical Engineering **1-3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

Advanced or applied topics in Chemical engineering offered according to student's interest and availability of instructors and equipment. Lecture hours, laboratory, and/or computation period to be arranged.

Computer Engineering

CPEG 110 Principles of computing **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

Through this course, students will explore major issues related to the "big ideas" of computational thinking and solve the problem by using Python, which emphasizes principles of computing, software development, style, and testing. Topics include representation of ideas with bits, basic Boolean logic, and devices to implement logic functions as the first part. The second part includes procedures and functions, iteration, recursion, arrays and vectors, strings, algorithms, exceptions, and object-oriented programming. Weekly labs provide guided practice on the computer

CPEG 111 Introduction to Computer Engineering **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

For CE students, this course is designed to provide foundation knowledge on basic digital system, computer architecture, programming, microelectronics, and electrical engineering. Students will learn concepts from both the hardware and the software perspective. Students can apply the knowledge and principles learnt to design and build a functional hardware-software co-designed system such as a robot.

CPEG 127 Concepts of Mathematics **3 Credits**
Grade Mode: Standard Letter, Pass/Non Pass

The course covers two important aspects, how to write rigorous mathematical proofs and how to use abstract concepts of mathematics in many areas of computer science. It will introduce the basic concepts for mathematical proofs and link them to different areas of mathematics and computer science. Other topics will be introduced, such as number theory, counting, algebra of sets, and graph theory.

CPEG 151 Fundamentals of Programming and Computer Science **4 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): CPEG 110

This course is designed to provide students with the main concepts and fundamentals of programming and computer science. Python is used as the programming language of this course. During class, students are taught syntax and semantics of Python, algorithmic design, and fundamentals of modern von Neumann architectures.

CPEG 152 Principles of Imperative Computing **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit, Pass/Non Pass
Prerequisite(s): CPEG 151 or CS 112

This course teaches imperative programming in a C-like language and methods for ensuring the correctness of imperative programs. It is intended for students familiar with elementary programming concepts such as variables, expressions, and functions. Students will learn the techniques needed to go from high-level descriptions of algorithms to correct imperative implementations, with specific applications to basic data structures. Much of the course will be conducted in a subset of C, with a transition to full C in the final part.

CPEG 213 Introduction to Computer Systems **4 Credits**
Grade Mode: Standard Letter, Pass/Non Pass
Prerequisite(s): CPEG 152 or CS 112

The course aims to help students become better programmers by teaching them the basic concepts underlying all computer systems. Students will learn what really happens when a computer program is run, so that they will have the intellectual tools to solve any potential problems that may arise. Topics include data representation, assembly language, memory hierarchy, exceptions, interrupts, Unix signals, system level I/O, process management, virtual memory and memory management, and network and concurrent programming.

CPEG 214 Electrical Circuit Theory **4 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): PHYS 207
Corequisite(s): MATH 308

This course focuses on the principles of Resistive circuits: circuit laws, Network reduction, nodal analysis, mash analysis; energy storage elements; sinusoidal steady state; AC energy systems; magnetically coupled circuits; the ideal transformer; resonance; and introduction to computer applications in circuit analysis.

CPEG 217 Probability Theory and Random Processes **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): MATH 251

This course covers important concepts and problem solving skills related to probability theory. Topics include elementary probability theory, conditional probability and independence, random variables, distribution functions, joint and conditional distributions, limit theorems, random processes spectral analysis and information theory.

CPEG 300 Embedded System Design **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit, Pass/Non Pass
Prerequisite(s): CPEG 152 and ECEN 325

In this class, the fundamentals of embedded system hardware and program design will be explored. Issues such as embedded processor selection, system architecture, instruction set, assembly programming, circuit debugging, and development tools will be discussed. The architecture and instruction set of the microcontroller will be discussed comprehensively, and two 8051 MCU boards will be used during the lab to implement embedded systems. Advanced AVR, STM microcontroller series will also be introduced in terms of their architecture and instruction set optimization.

CPEG 330 Data Structures **3 Credits**
Grade Mode: Standard Letter, Pass/Non Pass
Prerequisite(s): CPEG 152

This course focuses on the design of data structures (e.g., linked lists, stacks, queues, trees, and graphs), and an introduction to the analysis of algorithms that operate on those data structures. Students will learn how to implement learned data structures, their advantages/disadvantages, practical uses, alternatives, and time & space concerns.

CPEG 344 Digital Signal Processing **4 Credits**
Grade Mode: Standard Letter, Audit/Non Audit, Pass/Non Pass
Prerequisite(s): ECEN 314 and ECEN 325

This course covers discrete-time signals and linear time-invariant systems; digital processing of continuous-time signals; introduction to random signals, correlation and matched filtering; FIR and IIR digital filters and their analysis in the z and in frequency domains; the DFT (discrete Fourier transform) and its applications; FFT algorithms; FIR and IIR digital filter design and implementation techniques; spectrum analysis and estimation using windows; and practical applications of DSP algorithms

CPEG 410 Final Year Project I **4 Credits**
Grade Mode: Standard Letter

This course covers the first half of the Senior Design Project. Participants are then expected to form teams of 2—3 students per project. Each project requires the development of a larger prototype involving both hardware and software. Furthermore, two potential stake holders from industry, academia, and/or research lab shall be interviewed to solicit feedback on the project. Each participant has to successfully complete an research ethics and intellectual property module (lecture plus homework) before filing a mid-term report.

CPEG 411 Final Year Project II **4 Credits**
Grade Mode: Standard Letter
Prerequisite(s): CPEG 410

This pair of courses (CPEG 410 and 411) culminate in a major design experience based on knowledge and skills acquired in earlier course work. Students select their preferred projects and perform a 1-year long project development, including literature review, due diligence and familiarization with standards. Students shall then propose solutions, write a technical report, and conduct a final defense in front of the curriculum committee. This course also focusses on documenting and presenting the project's outcome in a professional manner.

CPEG 418 Introduction to Scientific Visualization **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): CPEG 152

The field of Scientific and Data Visualization is interdisciplinary, bringing together visualization experts and domain scientists seeking to gain visual insight into their data. Visualization is highly diverse, including applications coming from virtually every scientific discipline such as medicine, biology, mechanical and electrical engineering. This course provides a broad overview of the fundamentals Scientific and Data Visualization. Selected fundamental algorithms will be discussed in depth and their inner workings will be studied in programming and reading assignments.

CPEG 453 Information and Communication Technology Accessibility **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): CPEG 152

The course focuses on enhancing capabilities in the domain of ICT accessibility. When designing technology, developers need to consider people with functional limitations – persons with disabilities and the elderly. These vulernable groups face obstacles and challenges when it comes to the use of digital platforms. The course provides a comprehensive review by covering diverse topics that advance the skills needed to develop, review and evaluate the accessibile digital platforms according to the international best practices and ICT accessibility standards.

CPEG 460 Computer Networks **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): CPEG 152

This course focuses on the principles of computer networking protocols and architectures with emphasis of the Internet. Students will learn about the technologies and protocols used in local and wide area networks. Special emphasis will be given to study the TCP/IP protocol suite and its underlying protocols and concepts including: HTTP, SMTP, POP, IMAP, DNS, P2P, UDP, TCP, error control, flow control, congestion control, network routing (static and dynamic), packet delays, Local Area Networks (Ethernet, Wi-Fi), confidentiality, integrity, authentication. Students will experiment with protocol analyzers (packet sniffers) to understand and analyze the operations of the different TCP/IP protocols. Also, they will experiment with network emulation and virtualization using Mininet.

CPEG 462 Cybersecurity Fundamentals **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): CPEG 152

This course exposes students to the fundamental concepts of cybersecurity. Issues considered include topics such as cryptographic tools, user authentication, access control, software vulnerabilities, intrusion detection, firewalls, and operating systems security. Students will gain insight into the importance of cybersecurity through a series of practical and hands-on exercises. They will be exposed to real life cybersecurity operations, involving both attack and defense strategies.

CPEG 464 Introduction to Machine Learning **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): MATH 311 and CPEG 152

This course teaches the fundamentals of modern machine learning and artificial intelligence. Using the Python programming languages, students will learn "classical" machine learning techniques such as regression, SVMs, decision trees and random forests, as well as deep learning. The course focuses on the practical aspects of machine learning and covers a wide range of topics, including computer vision, data visualization, classification, regression, and segmentation. In hands-on sessions and assignments, students will set up their own machine-learning-based models.

CPEG 491 Internship **1-3 Credits**
Grade Mode: Audit/Non Audit, Pass/Non Pass

Supervised field experience of professional-level duties for a duration of 240 to 320 hours (6-8 weeks) at an approved internship site under the guidance of a designated site supervisor in coordination with a faculty supervisor. In addition to the regular reports during the internship, the student needs to prepare a written report and a presentation at the end discussing their internship activities and learning experiences.

Computer Science

CPEN 111 Introduction to Computer Engineering **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

For CE students, this course is designed to provide foundation knowledge on basic digital system, computer architecture, programming, microelectronics, and electrical engineering. Students will learn concepts from both the hardware and the software perspective. Students can apply the knowledge and principles learnt to design and build a functional hardware-software co-designed system such as a robot.

CPEN 127 Concepts of Mathematics **3 Credits**
Grade Mode: Standard Letter

The course covers two important aspects, how to write rigorous mathematical proofs and how to use abstract concepts of mathematics in many areas of computer science. It will introduce the basic concepts for mathematical proofs and link them to different areas of mathematics and computer science. Other topics will be introduced, such as number theory, counting, algebra of sets, and graph theory.

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Grade Mode: Standard Letter
Prerequisite(s): ENGR 110

This course is designed to provide students with the main concepts and fundamentals of programming and computer science. Python is used as the programming language of this course. During class, students are taught syntax and semantics of Python, algorithmic design, and fundamentals of modern von Neumann architectures.

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This course teaches imperative programming in a C-like language and methods for ensuring the correctness of imperative programs. It is intended for students familiar with elementary programming concepts such as variables, expressions, and functions. Students will learn the techniques needed to go from high-level descriptions of algorithms to correct imperative implementations, with specific applications to basic data structures. Much of the course will be conducted in a subset of C, with a transition to full C in the final part.

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The course aims to help students become better programmers by teaching them the basic concepts underlying all computer systems. Students will learn what really happens when a computer program is run, so that they will have the intellectual tools to solve any potential problems that may arise. Topics include data representation, assembly language, memory hierarchy, exceptions, interrupts, Unix signals, system level I/O, process management, virtual memory and memory management, and network and concurrent programming.

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Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): MATH 251

This course covers important concepts and problem solving skills related to probability theory. Topics include elementary probability theory, conditional probability and independence, random variables, distribution functions, joint and conditional distributions, limit theorems, random processes spectral analysis and information theory.

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Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): CPEN 152 and ECEN 325

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Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): ELEN 314 and ELEN 325

This course covers discrete-time signals and linear time-invariant systems; digital processing of continuous-time signals; introduction to random signals, correlation and matched filtering; FIR and IIR digital filters and their analysis in the z and in frequency domains; the DFT (discrete Fourier transform) and its applications; FFT algorithms; FIR and IIR digital filter design and implementation techniques; spectrum analysis and estimation using windows; and practical applications of DSP algorithms

CPEN 391 Internship **0 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

CPEN 410 Senior Design Project I **4 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

This course covers the first half of the Senior Design Project. Participants are then expected to form teams of 2—3 students per project. Each project requires the development of a larger prototype involving both hardware and software. Furthermore, two potential stake holders from industry, academia, and/or research lab shall be interviewed to solicit feedback on the project. Each participant has to successfully complete an research ethics and intellectual property module (lecture plus homework) before filing a mid-term report.

CPEN 411 Senior Design Project II **4 Credits**
Grade Mode: Standard Letter
Prerequisite(s): CPEN 410

This pair of courses (CPEN 410 and 411) culminate in a major design experience based on knowledge and skills acquired in earlier course work. Students select their preferred projects and perform a 1-year long project development, including literature review, due diligence and familiarization with standards. Students shall then propose solutions, write a technical report, and conduct a final defense in front of the curriculum committee. This course also focusses on documenting and presenting the project's outcome in a professional manner.

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CPEN 453 ICT Accessibility **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

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CPEN 462 Cybersecurity Fundamentals **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

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CPEN 464 Introduction to Machine Learning **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

This course teaches the fundamentals of modern machine learning and artificial intelligence. Using the Python programming languages, students will learn "classical" machine learning techniques such as regression, SVMs, decision trees and random forests, as well as deep learning. The course focuses on the practical aspects of machine learning and covers a wide range of topics, including computer vision, data visualization, classification, regression, and segmentation. In hands-on sessions and assignments, students will set up their own machine-learning-based models.

Core Science and Engineering

CSE 602 Statistics for Science and Engineering **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

This course covers probability and statistical methods for data analysis and experimental design. The course emphasizes on fundamental principles of statistics and their applications in science and engineering. Topics include: probability distributions and probability models; hypothesis testing based on single and multiple samples; single and multi-factor ANOVA; linear, logistic, and nonlinear regression; design, analysis, validation of experiments; nonparametric techniques; advanced statistical methods in scientific research.

CSE 603 Advanced Mathematics **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

This course introduces advanced math topics such as differential equations and their applications in energy and other engineering domains

CSE 605 Computational Data Analytics **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

It gains common computational tools for rapid analysis of several energy, environment and sustainability data sets.

CSE 606 Numerical Methods for Scientists and Engineers **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

Numerical Methods for Scientists and Engineers

CSE 607 Advanced Systems Optimization **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

This course focuses on introducing selected optimization tools for energy, environment and sustainability applications.

CSE 730 Hardware Security **3 Credits**
Grade Mode: Standard Letter

This course explores vulnerabilities and defenses at the intersection of hardware and system security. Students will study microarchitectural side channels, memory attacks, firmware/boot chain threats, trusted execution environments, and emerging hardware threats in cloud and IoT. Emphasis is placed on understanding the underlying computer engineering principles and evaluating real-world exploits and defenses.

CSE 770 Nano-Bio-Technology **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

Introduction to nanoscale bio-systems and the application of nano-bio-technology. Topics covered include nanomaterials synthesis and characterization, surface and interfaces properties, biohazard risk assessment, toxicity, drug deliver, diagnostics, lab-on-chip systems, hyperthermia, antimicrobials.

CSE 785 Innovation Entrepreneurship and Leadership I **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

This course first provides introductory discussions on theories of design innovation, entrepreneurship and leadership. Then, it focuses on experiential learning for design and development of products, processes, systems and business models. Topics include design thinking, system thinking, design process; understanding and developing user/stakeholder needs/input for a sustainable solution; generating technical and marketing specifications; and prototyping methods to reduce development time.

CSE 786 Innovation Entrepreneurship Leadership II **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

This course first provides introductory discussions on theories of design innovation, entrepreneurship and leadership. Then, it focuses on experiential learning for design and development of products, processes, systems and business models. Topics include design thinking, system thinking, design process; understanding and developing user/stakeholder needs/input for a sustainable solution; generating technical and marketing specifications; and prototyping methods to reduce development time.

Computer Science and Engineering

CSEG 605 Convex Optimization for Large-Scale and Distributed Systems **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

This course concentrates on solving convex optimization problems that arise in large-scale and distributed systems with applications to big data. It covers convex sets and functions, basics of convex analysis, least-squares, linear and quadratic programs, semidefinite programming, unconstrained and constrained optimization, duality theory, interior-point methods, sub-gradient and proximal gradient methods, splitting and alternating direction method of multipliers (ADMM).

CSEG 710 Advanced Algorithms and Data Structures **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

The course covers general computational problems, with a focus on the principles used to design those algorithms. Efficient data structures will be discussed to support these algorithmic concepts. Topics are: run time analysis, divide-and-conquer algorithms, dynamic programming algorithms, network flow algorithms, linear and integer programming, large-scale search algorithms and heuristics, efficient data storage and query, and NP-completeness. This course will focus on the design and analysis of algorithms for general classes of problems.

CSEG 780 Principles of Computer System Design **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

The course covers computer architecture, organization and design with an emphasis on the processor structure and functionality as well as memory hierarchy and IO devices. Topics include: Boolean algebra and digital logic; Combinatorial and sequential circuits; Processor datapath and control path; Memory hierarchy; IO devices; Static and dynamic CMOS circuits; low power techniques, design tools and methodologies. The course also contains several case-studies that explore recent real-world designs from the recent research literature. Students will design and verify small test circuits using commercial CAD tools.

Cyber Security

CYSE 610 Applied Cryptography **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

The course covers cryptographic primitives such as one-way, collision-resistant hash functions, as well as the relevant number theory and discusses public-key encryption and basic key-exchange coupled with real-life applications. In a nutshell, the course studies how two parties who have a shared secret key can communicate securely when a powerful adversary eavesdrops and tampers with traffic. The course will also cover popular secure protocols such as zero-knowledge proofs. Throughout the course students will be exposed to a variety of open problems in the field.

CYSE 630 Computer and Network Security **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

This course covers the concepts of assets, vulnerabilities, controls, threats and attacks, security measures and mechanisms. The course will introduce the fundamental concepts of security technology for computer networks, and the applications of these technologies. Topics include an overview of fundamental cryptography, authentication, encryption, digital signatures, digital certificates, and network security protocols such as IP Sec, SSL, etc. Students will also obtain the fundamental knowledge on network security mechanisms such as firewall and network intrusion detection systems.

CYSE 640 Security Risk Analysis **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

This course explores the basic elements of risk and to introduce security risk assessment methodologies and related tools used by many of the world's major corporations. The choice of the tools and methods in this course are based on its popularity in practice and enables the course to address cybersecurity issues related compliance with security policies, external standards and with appropriate legislation.

CYSE 720 Data Privacy **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

This course covers the concepts, technologies, practices and challenges associated with Information Security and Privacy, and a broad view of the subject, which includes looking at relevant business, organizational, human, legal and policy issues. The course combines technical discussions with a wealth of examples from enterprise and government systems, social networking, mobile and pervasive computing, privacy standards like HIPAA or GLBA, and much more. The course combines formal lectures with discussion of recent, hot topics and how they relate to data privacy and the multi-facet challenges in practice and real world.

CYSE 727 Wireless Networks & Security **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

The course explores the fundamentals of wireless networks as well as its security techniques and challenges. Students will learn a general overview of wireless networking standards, security issues and challenges in wireless networks, and security mechanisms in wireless technologies. Students will also learn security techniques in existing networks such as mobile ad-hoc networks, sensor networks, and wireless mesh networks as well as emerging networks such as smart grids, internet of things, and vehicular networks. Finally, the course will cover a general overview of physical layer security that exploits wireless channels for improving security of wireless networks.

CYSE 728 Distributed Systems Security **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

This course focuses on fundamental and advanced concepts in Distributed Systems, addressing their foundations, current technologies, and security aspects. Topics include, but are not limited to, distributed hash tables (peer-to-peer systems), failure detectors, synchronization, election, distributed agreement, consensus, gossiping, replication, key-value stores, NoSQL, blockchain technology. These topics are discussed in the context of real-life and deployed systems such as clouds and datacenters, databases, peer to peer systems, clusters, cryptocurrencies.

CYSE 729 Multimedia Security **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

This course has several objectives: (i) delivering fundamental and advanced concepts about multimedia content representation, (ii) highlighting the trade-offs between quality and multimedia channel capacity, (iii) designing and implementing security tools to protect multimedia content.

CYSE 730 Hardware Security **3 Credits**
Grade Mode: Standard Letter

This course explores vulnerabilities and defenses at the intersection of hardware and system security. Students will study microarchitectural side channels, memory attacks, firmware/boot chain threats, trusted execution environments, and emerging hardware threats in cloud and IoT. Emphasis is placed on understanding the underlying computer engineering principles and evaluating real-world exploits and defenses.

CYSE 744 Network Forensics **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

This course exposes students to practical issues involving the monitoring and investigation of private data communications. Issues considered include such topics as network monitoring, network data collection, network flows, and visual security analysis. Students will learn how to perform forensic investigations of network-based attacks, through a series of lab exercises, hands-on assignments, and a term project.

CYSE 745 Computational Forensics **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

This course builds the necessary awareness required to assess physical and digital crimes at local, regional and global levels. Assessment, in this context, includes the evaluation of the nature of the crime, handling and tracking physical and digital evidence connected to the crime in a manner consistent with legal requirements for presenting forensic evidence. Students will learn about various state-of-art computational tools used in forensic analysis of different types of evidence. The course also builds awareness of intelligence practices across the globe that have bearing on crime investigation, especially of organized crime

Data Science & Engineering

DSEG 660 Applied Deep Learning **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

This course covers intermediate-level topics in deep learning, including: deep neural network (DNN) components and architectures, DNN training and optimization, convolutional neural networks, recurrent neural networks, attention mechanism, reinforcement learning, and applications of deep learning in computer vision, speech recognition and natural language processing.

DSEG 682 Special Topics in Data Science and Engineering **3 Credits**
Grade Mode: Standard Letter

This course covers a variety of timely, cutting-edge areas in Data Science and Engineering. Taught by our faculty research scientists from our research institutes or industrials, this course allows students to keep up with critical trends and topics in the field of Data Science and Engineering.

DSEG 733 Advanced Data Management System **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

This course covers several advanced data management systems that are commonly used in practice. These include data warehouses, graph databases, column-oriented databases, distributed databases, cloud-based databases, and spatial databases. Topics include storage, indexing, query processing, protocol design, transactions processing and system architecture.

DSEG 735 Learning from Data **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

This course covers the theory, algorithms, and applications of computational learning. The technical topics covered include linear models, theory of generalization, regularization and validation, neural networks, support vector machines, as well as specialized techniques and a term-long project with big datasets.

DSEG 760 Machine Learning **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

This course deals with intermediate and advanced topics in machine learning. Topics to be covered include: linear regression, logistic regression, support vector machines, Bayesian networks, Markov network, conditional random fields, inference methods based on graphical models, learning methods for graphical models, and recent applications of machine learning methods.

Economics

ECON 215 Economic Analysis for Engineering **2 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): MATH 161, MATH 161

This course introduces students to the fundamental principles of economic analysis with a focus on their application in engineering contexts. Students will learn to assess the economic viability of engineering projects, considering factors such as cost estimation, financial forecasting, and risk analysis. Prerequisite: MATH 161.

Electrical Engineering

ELEN 209 Computer Programming and Algorithms **4 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): ENGR 110

Introduction to C language programming and common algorithms; computer systems; simple C programs; basic language constructs; file I/O; modular programming and functions; arrays and matrices; pointers and strings; simple data structures; searching, sorting, and numerical algorithms; algorithmic complexity.

ELEN 214 Electrical Circuit Theory **4 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): PHYS 217
Corequisite(s): MATH 318

Fundamental laws, electrical elements and sources, energy and power DC analysis of linear circuits Node and mesh analysis Operational amplifiers and op-amp circuits, Thevenin and Norton theorems Sinusoidal steady-state response and the phasor concept. Introductory concepts on complex frequency, average power in AC circuits Transient responses.

ELEN 215 Principles of Electrical Engineering **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): MATH 261 and PHYS 217, MATH 261; PHYS 217

This course covers basic principles of electric circuit analysis and an introduction to electronics tailored for engineering students not specializing in electrical and computer engineering. Prerequisite: MATH 261; PHYS 217.

ELEN 248 Digital Systems Design **4 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): MATH 162

Introduction to digital logicTopics include numbers and coding systems; Boolean algebra with applications to logic systems; Karnaugh and Quine-McCluskey minimization; combinatorial logic design; flip-flops; sequential network design; and design of digital logic circuits

ELEN 250 Machine Learning for Electrical Engineering **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): ENGR 110 and MATH 261

Engineering application-focused introduction to machine learning covering key machine learning concepts, guidance on selecting machine learning models, and application of python-based tools for data preparation, model development, and performance evaluation; practical engineering use-cases for machine learning from electronics, energy, motors, robotics, security, computer systems, and health; machine learning laboratory project including dataset management, ML model development, visualization, and deployment to an IoT platform showcasing ML expertise

ELEN 303 Random Signals and Systems **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): MATH 261

This course offers a comprehensive exploration of random signals and their engineering applications It includes probability theory, stochastic processes, and random variables, covering Gaussian and non-Gaussian processes, spectral analysis, correlation functions, and signal processing techniques Practical applications in communication, control systems, and information theory are emphasized, preparing students for complex system analysis and design Hands-on experiments and case studies enhance theoretical learning with practical implementation.

ELEN 314 Signals and Systems **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): ELEN 214 and MATH 318

Introduction to the continuous-time and discrete-time signals and systems; time domain characterization of linear time-invariant systems; Fourier analysis; filtering; sampling; modulation techniques for communication systems.

ELEN 322 Electric and Magnetic Fields **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): ELEN 214 and MATH 321

Vector analysis; static electric field; steady electric currents; static magnetic fields; time-varying fields and Maxwell's equations; plane electromagnetic waves.

ELEN 325 Electronics **4 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): MATH 321 and ELEN 214

Introduction to electronic systems; linear circuits; operational amplifiers and applications; diodes, field effect transistors, bipolar transistors; amplifiers and nonlinear circuits.

ELEN 335 Measurements and Instrumentation **4 Credits**
Grade Mode: Standard Letter
Prerequisite(s): ELEN 325, ELEN 325 and ELEN 314

This course introduces the principles, devices, and methods used in the instrumentation and measurement of electrical and non-electrical signals. Students will learn to select, calibrate, and operate instruments, as well as interpret measurement data. Topics include introduction to measurement systems, transducers and sensors, signal conditioning, calibration and standards, and applications in engineering. The course includes analog and digital measurements, analog to digital conversion (ADC) and digital to analog conversion (DAC) techniques. Prerequisite: ELEN 325 and ELEN 314.

ELEN 340 Electric Energy Conversion **4 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): ELEN 214

Fundamental topics in power and energy systems; phasors; three-phase circuits; self and mutual inductance; transformers; electromechanical systems; synchronous and induction machines; advanced concepts in electric energy conversion; DC-DC converters; inverters and rectifiers; solar and wind energy systems; DC and single-phase machines.

ELEN 349 Microprocessors and Embedded Systems **4 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): ELEN 209 and ELEN 248

This course is an introduction to the operation, interfacing, and applications of microprocessor-based systems, and real-time embedded system designTopics include memory organization, microprocessor architecture, embedded C programming, real-time programming, data path and control design of microprocessors.

ELEN 350 Computer Architecture and Design **4 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): ELEN 248

Computer architecture and design; use of register transfer languages and simulation tools to describe and simulate computer operation; central processing unit organization, microprogramming, input/output and memory system architectures.

ELEN 370 Physical Properties of Materials **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): PHYS 217

This course offers a comprehensive understanding of the fundamental principles governing the behavior and characteristics of materials, with focus on those used in electrical and electronic devices The course explores the relationship between the physical properties of materials and their performance in various engineering applications, with an emphasis on materials commonly employed in semiconductor devices, integrated circuits, and electronic components It includes an introduction to properties of conductors, semi-conductors, and insulators Definitions of stress and strain and mechanical behavior of solids Advanced characterizations of selected materials; circuit models for resistors, capacitors, inductors, junction, diodes, detectors, field-effect transistors, etc. Structure/property/ processing relationships will be also examined across a wide spectrum of materials including metals, ceramics, polymers and properties including electrical, magnetic, optical, thermal, mechanical, chemical and biocompatibility will be investigated Emerging Materials and Technologies applied for electrical, and electronics will be also studied.

ELEN 391 Internship **0 Credits**
Grade Mode: Pass/Non Pass

Participation in an approved high-impact learning practice, such as engaging with industry, research entities, or startup companies.

ELEN 403 Senior Design Project I **3 Credits**
Grade Mode: Standard Letter
Prerequisite(s): ELEN 349 and ELEN 314 and ELEN 370 and ELEN 325 and ELEN 303 and ELEN 322 and ELEN 335 and ELEN 340 and ELEN 350

This course is conducted as a guided project design course over a two-semester period, with the class divided into teams, each assigned a specific design project Periodic progress reports, a final written report, an oral presentation and project demonstration are required Cost analysis, societal impact, safety issues, evaluation of design alternatives and application of engineering principles will be emphasized A series of tutorials will be presented to provide student teams with insight into important system level considerations and tradeoffs.

ELEN 404 Senior Design Project II **3 Credits**
Grade Mode: Standard Letter
Prerequisite(s): ELEN 403

Continuation of ELEN 403. This course is conducted as a guided project design course over a two-semester period, with the class divided into teams, each assigned a specific design project Periodic progress reports, a final written report, an oral presentation and project demonstration are required Cost analysis, societal impact, safety issues, evaluation of design alternatives and application of engineering principles will be emphasized.

ELEN 410 Automatic Control Systems **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): ELEN 314 and MATH 318

Modeling and response of dynamic systems. Transfer functions, poles and zeros and their significance to transient and steady state response of feedback systems. Analysis of stability of closed-loop systems. Steady state errors and transient performance of closed-loop systems. Design of feedback control systems by root locus techniques and by frequency domain methods. Laboratory projects include modeling, controller design, controller realization, system performance evaluation, and simulation studies.

ELEN 412 Power Electronics **4 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): ELEN 214

Modeling and response of dynamic systems. Transfer functions, poles and zeros and their significance to transient and steady state response of feedback systems. Analysis of stability of closed-loop systems. Steady state errors and transient performance of closed-loop systems. Design of feedback control systems by root locus techniques and by frequency domain methods. Laboratory projects include modeling, controller design, controller realization, system performance evaluation, and simulation studies.

ELEN 414 Electric Power Systems **4 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): ELEN 214 and ELEN 314

This course will introduce students to basic methods of electric power systems Topics include AC circuits, phasors, complex power and complex impedance, transformers, per unit system, transmissions lines, power flow, economic dispatch, real and reactive power control, symmetric and unsymmetric faults, transient stability, relaying and protection.

ELEN 416 Electric Machines and Drives **4 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): ELEN 214 and ELEN 322

This is an introductory course on electric machines and drive systems and their application in HEV/PHEV powertrain and other industrial and residential systems. The objectives are to familiarize the students with the basic concepts of electromechanical energy conversion and electric drive systems. Students are expected to be able to analyze and design electric drive systems for automotive, industrial, and residential applications. The topics covered in this course include DC machines, induction machines, permanent magnet synchronous machines, and switched reluctant motors and drives. Case studies in automotive applications such as electric and hybrid drivetrains, industrial and residential electric variable speed drive systems, will be discussed.

ELEN 418 Renewable Electric Power Systems **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): ELEN 340

This course is an introduction to traditional power grids as well as renewable electric power systems. This course covers long-distance transmission of electric power with emphasis on admittance and impedance modeling of components and systems, complex power-flow studies, symmetrical and unsymmetrical fault calculations, economic operation of large-scale generation and transmission systems, an overview of emerging renewable energy technologies (eg wind and solar) and the impact of grid integration of renewable energy on power grids.

ELEN 420 Linear Control Systems **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

Application of state variable and frequency domain techniques to modeling, analysis and synthesis of single input, single output linear control systems.

ELEN 429 Machine Learning for Signal Processing **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

Principles of pattern recognition and machine learning and electrical and computer engineering applications in signal estimation, detection and classification, detection of patterns in engineering systems and communications networks, assessment of normality and abnormality patterns in biomedical engineering applications and cyber security of power systems.

ELEN 430 Digital Signal Processing **4 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): ELEN 314

Digital signal processing; discrete-time signals and systems, linear shift-invariant systems, the discrete Fourier transform and fast Fourier transform algorithm, and design of finite impulse response and infinite impulse response digital filters.

ELEN 431 Digital Communications **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

Digital transmission of information through stochastic channels; analog-to-dialog conversion, entropy and information, signal detection, the matched-filter receiver, probability of error; baseband and passband modulation, signal space representation of signals, PAM, QAM, PSK, FSK; block coding, convolutional coding; synchronization; simulation of digital communication systems.

ELEN 432 Wireless Communications **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): ELEN 314

This course provides an introduction to the fundamentals of modern wireless communication. The focus of this course will be on the (i) basic signal propagation issues and channel impairments, (ii) modulation schemes and bandwidth/power trade-offs, and (iii) overcoming channel impairment using equalizers, diversity and channel coding. Additionally, case studies will examine current wireless LANs and cellular system

ELEN 434 Radar and Remote Sensing **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): ELEN 314 and ELEN 322

This course delves into fundamental radar concepts, including radar waveforms, signal processing, antenna design, and radar cross-section analysis It also covers remote sensing techniques, such as passive and active sensing, multispectral and hyperspectral imaging, synthetic aperture radar (SAR), and lidar systems. Students learn about system design considerations and implementation, including system requirements analysis and hardware/software design. Advanced topics like laser theory and applications are explored in detail during the spring session, complementing the foundational concepts covered in the course.

ELEN 436 Image Processing **4 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): ELEN 314 and ELEN 303

Fundamentals of physics and the engineering principles of medical imaging systems; focus on magnetic resonance imaging, x-ray computer tomography, ultrasonography, optical imaging and nuclear medicine; includes systems, sources, energy tissue interaction, image formation and clinical examples; virtual labs, on- and off-campus lab tours.

ELEN 438 Power Electronics **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

Electric power conditioning and control; characteristics of solid state power switches; analysis and experiments with AC power controllers, controlled rectifiers, DC choppers and DC-AC converters; applications to power supplies, airborne and spaceborne power systems.

ELEN 440 Principles of Artificial Intelligence **4 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): ELEN 250 and ELEN 349

Basic concepts and methodology of artificial intelligence from a computer engineering perspective. Emphasis is placed on the knowledge representations, reasoning and algorithms for the design and implementation of intelligent systems. Introduction to an AI language and representative intelligence systems. A design project is required.

ELEN 442 Deep Learning for Robotics **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): ELEN 250 and ELEN 350

This course covers the application of deep learning techniques in robotics, focusing on perception, control, and decision-making. Students will learn about applying deep learning models to robotic vision, navigation, and manipulation. Through hands-on projects, students will design and train deep learning models for real-time robotic systems.

ELEN 446 VLSI Design **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): ELEN 325

This course covers the design and implementation of integrated circuits, including CMOS technology, digital logic design, and layout techniques. The course emphasizes hands-on experience with VLSI design tools and the development of practical skills in designing, simulating, and testing VLSI circuits.

ELEN 448 CMOS Digital Circuit Design **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): ELEN 325

This course focuses on the design and analysis of CMOS digital circuits. Students will explore the principles of CMOS technology, logic gate design, and circuit optimization techniques. Emphasis is placed on understanding the trade-offs in performance, power, and area. Practical experience will be gained through the use of industry-standard design tools for simulation and layout.

ELEN 449 Microprocessor Systems Design **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

Introduction to microprocessors; 16/32 bit single board computer hardware and software designs; chip select equations for memory board design, serial and parallel I/O interfacing; ROM, static and dynamic RAM circuits for no wait-state design; assembly language programming, stack models, subroutines and I/O processing.

ELEN 455 Digital Communications **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

Digital transmission of information through stochastic channels; analog-to-dialog conversion, entropy and information, Huffman coding; signal detection, the matched-filter receiver, probability of error; baseband and passband modulation, signal space representation of signals, PAM, QAM, PSK, FSK; block coding, convolutional coding; synchronization; communication through fading channels; spread-spectrum signaling; simulation of digital communication systems.

ELEN 489 Selected Topics in Electrical Engineering **1-3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

Advanced or applied topics in electrical engineering offered according to student's interest and availability of instructors and equipment. Lecture hours, laboratory, and/or computation period to be arranged.

Engineering

ENGR 110 Introduction to Programming **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

Through this course, students will explore major issues related to the "big ideas" of computational thinking and solve the problem using Python, which emphasizes computing, software development, style, and testing principles. Topics include the representation of ideas with bits, basic Boolean logic, and devices to implement logic functions as the first part. The second part contains procedures and functions, iteration, recursion, arrays and vectors, strings, an operational model of procedure and function calls, algorithms, exceptions, and object-oriented programming. Weekly labs provide guided practice on the computer, with staff present to help. Assignments use procedural code and algorithms to help develop fluency and understanding of the programming language.

ENGR 125 AI Literacy and Critical Thinking **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

This course introduces students to the fundamentals of Artificial Intelligence (AI) and fosters critical thinking skills. Students will learn about the basic concepts, applications, and ethical considerations of AI technology. The course emphasizes developing AI literacy, enabling students to understand and analyze AI's impact on society, industry, and daily life. Through discussions, case studies, and hands-on projects, students will enhance their ability to think critically about AI-related issues, evaluate information sources, and make informed decisions in an AI-driven world.

ENGR 130 Sustainable Cities and Urban Mobility **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

This course explores the principles and practices of designing sustainable cities and improving urban mobility. Students will examine the challenges and solutions related to urbanization, transportation, and environmental sustainability. Key topics include sustainable urban planning, green infrastructure, public transportation systems, and smart city technologies. Emphasis will be placed on integrating environmental, economic, and social considerations in urban development. Through case studies, projects, and interactive discussions, students will learn to develop innovative strategies for creating livable, resilient, and efficient urban environments.

ENGR 210 Introduction to Innovations and Technology Entrepreneurship **1 Credit**
Grade Mode: Standard Letter

ENGR 482 Engineering Ethics **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

This course teaches the fundamentals of ethics as they apply to engineering disciplines. It provides students with the foundational skills to reflect on their solutions' and inventions' impact on society critically and work for the greater good of humanity. This is of particular importance in today's data- and AI-driven world of automated decision-making.

Finance

FIN 101 Ethical Finance **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

The course aims is to discuss and analyze the ethical approaches related to finance and economics. These include Corporate Responsibility and Responsible Investment, Islamic finance and economy, financial inclusion, Investor ethics and impact investing, environmental, social and governance (ESG) factors as well as the ethics of fintech.

History

HIST 115 History & Theory of Architecture - Islamic/Arab Civilizations **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit, Pass/Non Pass

This course covers the methods and theories of Islamic civilizations that stretched from Spain to India. This course focusses on the architecture and decoration of the societies across this vast area, from the early centuries of Islam in the seventh century to present. It covers major architectural masterpieces and how they differed and changed with regards to their geographic locations, traditions, and how they developed. The course covers major monuments of the Umayyad, Abbasid, Tulunid, Fatimid, Samanid, Seljuk, Ghaznavids, Ayyubid, Mamluk, Ilkanid, Timurid, Ottoman, Safavid, Mughal and Modern periods.

Hospitality, Retail & Sport Management

HRSM 650 Field Project in Hospitality, Retail and Sport Management **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

This course even though intended to provide a student with practical work experience, the field project is also an academic course with corresponding assignments and projects. These assignments and projects should stimulate the student to maximize his or her experience and integrate classroom learning with real world application.

HRSM 700 Quantitative Methods in Hospitality, Retail, and Sport Management **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

This course aims to equip students with knowledge and understanding of quantitative methods used in the fields of hospitality, tourism, and sport management. The course covers basic statistical concepts, principles, and methods required for scientific investigation of research problems in HRSM. The primary topics will include descriptive statistics, confidence interval, hypothesis testing, bivariate correlation, simple linear regression and multiple linear regression analyses. Students will learn how to analyze research data and utilize statistical output for reporting research findings.

HRSM 788 Business Analytics in Hospitality, Retail and Sport Management **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

This course introduces students to the methods and application of business research in the areas of hospitality, retail, and sport management. Areas covered include the study of the research process, research designs, sampling procedures, measurement techniques, survey research, hypothesis testing, and the research report. After successful completion of the course, students will be able to use research methods to solve problems for firms in their respective industries.

Information Computation & Technology

ICT 601 Research Methods and Ethics **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

This course is a foundational course for graduate students who will be engaged in research. It provides students with an introduction to ethics and ethical misconduct, intellectual property and environmental health and safety as well as scientific thought and design of experiments. A focus of the course is to transition students from textbooks to primary literature as their main source of information.

ICT 615 AI for Social Media and Multimedia Applications **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

This course covers fundamental and novel artificial intelligence (AI) technologies for social media and multimedia applications. The students will read and present selected references about AI for social and multimedia computing, and learn the hands-on skills to implement or modify existing AI algorithms. Beside these technical understanding of involved AI technologies, the students will propose and implement creative social media or multimedia applications using AI technologies. The student will complete assignments, class-activities and projects individually or in groups

ICT 620 Computer Graphics **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

This course is at the core of visual computing. It provides an overview over the fundamentals of computer graphics such as digital representations for 3D models, GPU-accelerated OpenGL, rasterization, ray-tracing, shading, lighting, texturing, etc. Selected advanced and hot topics will also be covered. The course will be complemented by practical assignments using WebGL, running in any modern web browser and providing students with immediate visual feedback.

ICT 621 Visual Computing **3 Credits**
Grade Mode: Standard Letter

This course introduces students to the field of visual computing, including visualization, computer vision, virtual reality, and 3D deep learning. It emphasizes practical skills in creating visual applications and analyzing visual data, with hands-on projects using WebGL, Python, and AI-based toolkits. The course is ideal for students in data science and ICT-related fields who want to gain fluency in modern visual intelligence technologies.

ICT 632 Advanced Applications of the Web and Internet **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

This course covers advanced techniques for building and maintaining practical applications of the Web and Internet. Main topics include web services, search engines, mobile web, practical aspects of the backbone techniques of the web, solutions for dealing with the rapidly growing and evolving web, and algorithms for handling the uncertainties in web data. The course will also cover selected topics of the state-of-the-art applications of the web techniques. The course is interdisciplinary in nature and has a wide breadth.

ICT 660 Principles of Health Informatics **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

The objective of this graduate level course is to provide data science students with an overview of the Health Informatics domain and introduce them to major concepts, areas, and ideas evolving within the discipline of Health Informatics. Key challenges and opportunities for the health data scientist will be highlighted. Students will gain insights and develop a solid base in understanding, analyzing and evaluating health information systems to support data science research and projects.

ICT 665 Artificial Intelligence and Machine Learning in Healthcare **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

This course covers both mathematical concepts and tools related to artificial intelligence (AI), with their application in real-world healthcare problems. Topics will cover concepts on uncertainty, searching algorithms, classification techniques, clustering techniques and application of AI in solving different healthcare related problems. This course will concentrate on building machine learning models to solve different open research problems in the field of genomics, bioinformatics, cheminformatics, drug discovery, healthcare etc.

ICT 666 Computational Bioinformatics **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

The aim of this course is to introduce the fundamental of bioinformatics algorithms and different bioinformatics methods for health management and life science students and researchers. It aims to give an overview of genomic and epidemiologic questions and to communicate the statistical and computational ideas behind the key analysis methods in these fields. This course does not assume that the student has a background in molecular biology, but rather introduces both the biological and mathematical concepts.

ICT 668 Medical Image Processing **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

The first part of this course introduces medical imaging, with a focus on magnetic resonance imaging, x-ray computer tomography, ultrasound, and nuclear medicine. The second half of the course introduces students to basic concepts in digital image and signal processing. After an introduction to the area of image processing and a brief mathematical review, we will cover the fundamental techniques of image processing, including image enhancement in spatial and frequency domains, image restoration, image segmentation, image description, and mathematical morphology.

ICT 670 Information Technology Project Management **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

The course addresses the growing need for better management of information technology projects. It covers the key elements of the project management framework, including project stakeholders, the project management knowledge areas, common tools and techniques, and project success. It covers planning methods and techniques required for defining, planning, integrating and implementing information technology projects consistent with the organizational strategic plan and mission. On successful completion of the course, students will have a good understand of the relationship between project, program, and portfolio management and the contributions they each make to enterprise success. They should be able to explain what a project is, provide examples of information technology projects, list various attributes of projects, and describe the triple constraint of projects.

ICT 671 Information Systems Management **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

The course focuses on issues managers face in the selection, procurement, use, and management of information technology assets. It presents a detailed study of the issues, principles, techniques and best practices in managing information systems and enterprise knowledge as organizational resources. Topics include IT operations, information technology and strategy, information technology and organization, assets management, performance evaluation and benchmarking, hardware and software acquisition, physical environments and security issues, outsourcing and partnerships.

ICT 675 Healthcare Information Systems **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

The course provides the basic foundations and tools needed to understand, manage, and evaluate information systems effectively within a healthcare environment. The course will review health information system related regulations and standards and explore relevant issues pertaining to middle and senior level management working within the health care information system domain.

ICT 676 Information Systems Analysis and Design **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

The course develops comprehensive theoretical knowledge as well as practical skills related to the development process of information systems. This course deals with the concepts, skills, methodologies, techniques, tools, and perspectives essential for systems analysts. Upon successful completion of the course, students should be able to gather data, analyze and specify the requirements of a system, design system components and environments, build general and detailed models that assist in implementation and validation of the system and its compliance to the requirements, preferences and constraints of its social and organizational environment.

ICT 690 Special Topics **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

Special topics in ICT allow students to examine a variety of timely, cutting-edge areas in ICT. Taught by our faculty research scientists from our research institutes or industrials, this course allows students to keep up with critical trends and topics in the field.

ICT 695 Master's Thesis Hours **1-6 Credits**
Grade Mode: Pass/Non Pass

ICT 698 Industrial/ Project **1-6 Credits**
Grade Mode: Standard Letter, Pass/Non Pass

ICT 701 Graduate Research Seminars **0 Credits**
Grade Mode: Standard Letter, Pass/Non Pass

Research seminar to be presented by invited speakers as well as students. Satisfactory attendance and presentations lead to the grade Pass.

ICT 705 Applied Data Analytics **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

This course covers cutting-edge algorithms and software tools for data analysis, including the analysis of various types of data such as time series, texts and images. Main topics include data visualization, advanced regression and classification solutions, advanced data reduction techniques such as dimensionality reduction and kernel PCA, as well as application-specific tools and methods. In addition, the course also introduces common software tools and libraries which can be used as building blocks for designing and developing novel data analysis applications.

ICT 706 Independent Studies **3 Credits**
Grade Mode: Standard Letter

Independent studies offers an opportunity for students to perform independent research work in any area related to Computer Science and Engineering under the supervision of a faculty member.

ICT 716 Data Science Tools and Applications **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

The course objectives are to equip the graduate students with intermediate-level concepts and tools of data science, their properties, and their applications to practical problems. Furthermore, knowledge of how to apply these data science concepts and tools to solve real-world problems in health, engineering, finance, transportation and energy will be important objectives.

ICT 717 Computer Vision **3 Credits**
Grade Mode: Standard Letter

This course introduces students to the fundamental concepts, algorithms, and applications of computer vision. Students will learn how computers can be trained to interpret and understand visual data from the world. The course covers classic vision topics such as image filtering, feature detection, and stereo vision, as well as modern topics including deep learning for vision tasks. Emphasis will be placed on practical implementation, algorithmic understanding, and the design of end-to-end vision systems.

ICT 718 GenAI - Generative AI Foundations **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

This course provides a comprehensive exploration of Generative AI (GenAI) models, focusing on their mathematical and computational foundations. It covers Deep Learning, Autoregressive Models, Flow Models, Latent Variable Models, Generative Adversarial Networks, Diffusion Models, and Large Language Models (LLMs) such as Transformers. Emphasis is placed on alignment, safety, adversarial robustness, and ethical considerations. Through project-based learning and research-driven assignments, students will gain hands-on experience in implementing, evaluating, and deploying state-of-the-art GenAI models in practical scenarios.

ICT 720 Cloud Computing **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

The course focuses on the technologies associated with the cloud computing infrastructure and the usage of the cloud in different application domains. The first part of this course introduces core cloud computing architectures and basic concepts. The second part of the course delves into systems aspects such as fault tolerance, consistency, resource allocation, and quality of service in the context of particular cloud applications, such as distributed machine learning algorithms, real-time multimedia, or cloud-enabled Internet of Medical Things.

ICT 725 Quantum Computing **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

This course aims to provide a solid understanding of the fundamentals of Quantum Computing. In the first half, we give an overview of Quantum Mechanics and its mathematical treatment. We then introduce the building blocks of Quantum Computing and discuss how they work, how to build them, and their physical realization. In the second half, we introduce Quantum Cryptography and Quantum Machine Learning, as examples of Quantum Computing applications. Finally, we conclude with discussion on Quantum Information theory.

ICT 726 Quantum Machine Learning **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

Quantum computing revolutionizes computation by efficiently solving classically intractable problems, disrupting and advancing countless applications. The course will focus on Quantum Machine Learning (QML). It introduces QML and explains how it advances Machine Learning. It will introduce basic QML topics, such as quantum support vector machine, quantum kernel methods, and quantum neural networks. It will then explore advanced QML topics, including Fault-Tolerant QML and Quantum Generative Adversarial Network. The course concludes with other applications of quantum computing beyond QML

ICT 730 System Performance Modelling and Analysis **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

During their graduate studies, graduate students often aim to develop new concepts and techniques to enhance certain performance metrics of the system they are investigating, but often lack the right methods they need to use to evaluate and assess the effectiveness of such developed concepts and techniques. This course covers various methods that graduate students can use to model, characterize and analyze the performances of their designed techniques and concepts.

ICT 736 Interactive Design for Health care **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

This course exposes students to the healthcare domain at large, including being involved in existing project work within medical institutes in Qatar. The students will study a variety of cutting-edge user-centered interactive technologies that are currently being used and can potentially be used in the near future to support healthcare. The students will pair up in groups of 2 and explore the introduction of new interactive technology in one of the domains discussed in class.

ICT 890 Dissertation Hours **1-9 Credits**
Grade Mode: Pass/Non Pass

Logistics & Supply Chain Management

LSCM 601 Research Ethics and Methods **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

This LSCM core course prepares students for performing graduate level research. It introduces students to multi-disciplinary methods for critical exploration of research, locating and summarizing and critiquing relevant literature, developing a research problem, framing a problem with an appropriate research method, and constructing a coherent research design. One focus will be on an introduction to ethics and ethical misconduct. Throughout the course, students will be developing a causal model, will be acquainted with peer review, and will be developing a research proposal.

LSCM 605 The Pricing of Financial Contracts **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

This course serves as an introduction to financial markets, the models of risky assets and the theory of pricing contracts based on these assets. The course exhibits the basic features of financial derivatives These instruments are defined, their payoffs and the markets in which they are traded are considered, and the importance of valuing these instruments in the absence of arbitrage is discussed. The course will provide students with a thorough understanding of the mechanics of financial markets.

LSCM 607 Optimization Models and Methods **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

This course covers a thorough understanding of optimization methods and models. On successful completion of the course, students will be able to: define and formulate linear programming problems and appreciate their limitations; solve linear programming problems using appropriate software and computer packages, and interpret the results obtained; conduct and interpret post-optimal and sensitivity analysis; and explain the primal-dual relationship. Moreover, students will be able to formulate and solve a wide range of traditional logistics and supply chain combinatorial problems. Students will also be exposed to some well-known advanced optimization techniques that might be covered in other electives.

LSCM 611 Supply Chain Management **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

This course aims at showing that any organization must be analyzed as a component of a Supply Chain in which the different actors (suppliers, manufacturers, retailers) as well as the different functions (marketing, production, finance) interact. Understanding and mastering the relationships between these different areas will improve the effectiveness (achieving the objectives) and the efficiency (achieving the results at least cost) of the system.

LSCM 617 Production and Operations Management **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

Production & Operations Management is defined as the set of processes which transform the inputs/resources of an organization into final goods /services through a set of defined, controlled and repeatable policies. This course covers a thorough understanding on managerial processes for effective operations in both goods-producing and service-rendering organization. Emphasis is on specific tools and strategies used to manage and enhance a firm's operations and production, such as Inventory management, Demand forecasting and Production Planning and Scheduling. The course will also introduce simulation modelling to solve complex operations management problems.

LSCM 621 Project Management in Logistics **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

This course prepares students for managing projects, with a special focus on large-scale projects for logistical infrastructures in aviation and shipping (i.e. airports and seaports). Part 1 will focus on managing large-scale projects. Here, essentials about the concept of project management will be presented and discussed from a business administration point of view. Part 2 will apply these methodological essentials to projects for logistical infrastructures in aviation and shipping.

LSCM 625 Behavioral Logistics Management **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

The course focuses the students on being able to explain, rather than to only describe, approaches to strategic challenges of logistics management. Here, there are no uniform solutions. Complexity and causality are two constructs to be dealt with in strategic logistics management. The conceptualization and analysis of cause-effect-cause systems is critical for decision-making. Therefore, quantitative approaches as well as qualitative approaches (i.e. focusing on the behavior) are elements of decision making for strategic challenges.

LSCM 627 Simulation Optimization Methods **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

The course introduces decision support systems based on simulation optimization methods to solve complex problems by finding better input values of continuous and discrete variables from among all possibilities without explicitly evaluating each possibility. Simulation optimization methods aims to minimize solving resources spent while maximizing the information obtained in a simulated or measured experiment. Major difficulties from lack of analytical formulation, presence of uncertainties, nonlinearities, non-differentiable functions, very expensive and time-consuming optimized solutions force the use of simulation-based optimization approaches when solving multi-scope, multi-scale and multi-scenario problems as those found in industrial manufacturing and supply chains.

LSCM 631 Port Management and Maritime Logistics **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

The course examines how ports are organized, managed and planned, and how ports interface with the logistics chain. The course provides necessary knowledge and understanding of the principles and evolution of container terminal management, port indicators, maritime supply chain management and environmental issues that arise from port operations and maritime transportation.

LSCM 635 Business Performance Management **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

This course focuses on interdisciplinary approaches to financial and operational performance measurement and management. The course emphasizes an exploratory- and explanatory-focused approach in that students develop case studies. In order to build these on a framework, the course introduces the conceptual approaches to performance management with an emphasis on logistical systems. The course highlights the current research in the management domain. Both, the theoretical and the reseach parts are aimed at building the framework for students to built their cases.

LSCM 641 Facility and Transportation Management **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

This course is emphasizing on applying industrial engineering principles and techniques to analyze, design and improve facility layout and transportation networks in industrial enterprises and services systems. In addition to bringing together the knowledge gained in many previous courses, the topics of this course include tools and methods for planning new facilities and transportation networks and to revise or expand existent ones.

LSCM 643 Data Analytics for Supply Chain Optimization **3 Credits**
Grade Mode: Standard Letter

This course introduces probability, statistics, and programming for data analysis, focusing on operations and supply chain management. Students learn key statistical concepts, including probability distributions, hypothesis testing, regression, and inference. It covers machine learning techniques like classification, clustering, and predictive Modelling for data-driven decisions. Hands-on experience in Python enables data manipulation, visualization, and statistical modeling. By applying these skills, students analyze and interpret real-world supply chain and operational data effectively.

LSCM 644 Transportation Analytics **3 Credits**
Grade Mode: Standard Letter

This course covers Modelling and implementing key transportation and routing problems in logistics and supply chains. Topics include the Traveling Salesman Problem, Vehicle Routing, Inventory Routing, and Network Design, with applications in maritime, rail, and urban logistics. Students will explore optimization techniques, algorithm development, and case studies to solve complex transportation challenges. By the end, they will gain hands-on experience in advanced methodologies, preparing them for research or industry roles in transportation and supply chain optimization.

LSCM 651 Financial Techniques for Investment Appraisal **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

The course introduces students to basic mathematical models for assessing investments and projects taking place over a period of time. The course explains how concepts of compound interest and discounting are used to value payments to be made in the future. Compound interest functions are introduced and formulae for regular or varying payments made for specified periods are derived. Practical applications are demonstrated by analysing problems relating to investments such as bonds and ordinary shares.

LSCM 671 Principles of Reinforcement Learning for Engineering Management **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

The course will introduce the Principles of Reinforcement Learning (RL) for Engineering Management. Starting from the basics of Markov Decision Processes (MDP) the course will cover a broad set of techniques including Value Iteration, Policy Iteration, Q-Learning, Policy Gradient, Actor-Critic Methods. The use of function approximation techniques (including Neural Networks) to approximate the state-space will be elaborated. Applications from Traffic Management, Logistics and Supply Chains will be introduced to apply theory to practice.

LSCM 690 Applied Project **1-6 Credits**
Grade Mode: Pass/Non Pass

Fulfilling curriculum requirements in the form of an applied industrial project

LSCM 695 Master's Thesis Hours **1-6 Credits**
Grade Mode: Pass/Non Pass

Fulfilling curriculum research requirements.

LSCM 701 Research Seminar **0 Credits**
Grade Mode: Pass/Non Pass

The LSCM research seminars will consist of industrial professionals and academics in the field of logistics and supply chain management. The objective of which is to expose participants to the latest trends in research and industrial practices within logistics and supply chain management.

LSCM 706 Independent studies **3 Credits**
Grade Mode: Standard Letter

This course offering is designed to enable independent studies by student in special topics.

LSCM 711 Supply Chain Modeling and Optimization **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

This course will review the major supply chain innovations developed over the last four decades. The course is specifically designed to address the issue the decision making processes of the dynamic complexities within supply chains using modeling and optimization approaches. These innovations have transformed tremendously supply chains especially through Information Technology and digitalization enablers. Most of the modeling will be performed using basic tools such as Excel Solver as well as learning about the evolving supply chain innovations.

LSCM 721 Advanced Topics in Supply Chain Management **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

This course extends the knowledge acquired in basic courses in order to learn advances tools to model and solve quantitative problems arising in supply chain management. The course will focus not only the deterministic context but will cover even the stochastic settings in which the input data are not known with certainty in advance but can be represented through a probability distribution. Specialized software packages will be also used in order to solve real-life logistics applications in reasonable amount of time.

LSCM 731 Industry 4.0 in Manufacturing and Supply Chain **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

The course introduces the fundaments related with the Industry 4.0 in manufacturing and its interface with the qualogistics chain considering both logistics and qualities aspects of the supply chain. The course provides necessary knowledge and understanding of the evolution of the industrial activities and supply chain management toward the so called smart production and high-performance qualogistics that arise from the technologies in this new industrial era.

LSCM 741 Machine Learning for Supply Chain Management 3 Credits
Grade Mode: Standard Letter, Audit/Non Audit

This course caters to PhD and Master's students, offering a deep dive into the synergy between machine learning and supply chain management. Focused on practical applications, it provides expertise in utilizing Python and PyTorch for optimizing supply chain operations. Covering aspects from demand forecasting to transportation optimization, participants tackle real-world challenges through lectures, case studies, and projects. Graduates gain a robust understanding of machine learning's strategic application in modern supply chains, enabling data-driven decision-making for careers in academia or industry

LSCM 742 Cutting-Edge Techniques in Prescriptive Analytics 3 Credits
Grade Mode: Standard Letter

This course covers advanced optimization theory and practice, focusing on integer and combinatorial optimization, relaxation techniques, polyhedral approaches, and cutting-plane algorithms. Topics include dynamic programming, reformulation, and decomposition methods such as Lagrangian relaxation, Dantzig-Wolfe, column generation, and Benders decomposition. Emphasis is placed on real-world logistics and supply chain applications. Designed for PhD students, the course equips them with practical and theoretical tools to tackle complex optimization challenges in research and industry settings.

LSCM 743 Stochastic Modelling and Optimization 3 Credits
Grade Mode: Standard Letter, Audit/Non Audit

This graduate course introduces decision-making under uncertainty, focusing on stochastic optimization in logistics and supply chain management. It covers Modelling uncertainty, key decision parameters, and optimization challenges. Students explore real-world applications in logistics, transportation, health, energy, and finance while learning stochastic programming theory, modeling, and solution methods. Emphasizing interdisciplinary approaches, the course is ideal for those with backgrounds in linear programming, probability, and mathematical modeling. Students engage in research, literature review, problem identification, and stochastic system modeling.

LSCM 890 Dissertation Hours 1-9 Credits
Grade Mode: Pass/Non Pass

Fulfilling curriculum research requirements.

Mathematics

MATH 160 Functions, Trigonometry, and Linear Systems 4 Credits
Grade Mode: Standard Letter, Audit/Non Audit

MATH 161 Engineering Mathematics I 4 Credits
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): MATH 160 or Math Placemnet Exam with a score of 22, Passing placement test; MATH 160

This course delves into advanced calculus topics essential for mathematical analysis and problem-solving. Students explore vectors, parametric equations, and vector functions, along with inverse trigonometric functions. Derivatives are extensively covered, including polynomial, exponential, trigonometric, and logarithmic functions, employing rules like product, quotient, and chain rules. Additionally, applications like exponential growth, related rates, and optimization are addressed. Integration techniques, including definite and indefinite integrals, are studied, alongside their applications in areas, distances, and the fundamental theorem of calculus. Emphasis is placed on understanding concepts deeply and applying them to real-world scenarios. Prerequisites: Passing placement test; MATH 160.

MATH 162 Engineering Mathematics II 4 Credits
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): MATH 161, MATH 161

This course provides a comprehensive exploration of advanced calculus concepts and techniques. Topics include integration methods like the Substitution Rule and integration by parts, along with applications such as finding areas between curves and volumes using various methods. Sequences, series, and convergence tests are covered, alongside power series and Taylor/Maclaurin series. Calculus in polar coordinates, including curves, areas, lengths, and conic sections, is also introduced. Emphasis is on mastering these concepts and applying them to real-world problems, preparing students for advanced mathematical analysis. Prerequisite: MATH 161.

MATH 211 Principles of Statistics 3 Credits
Grade Mode: Standard Letter, Audit/Non Audit

MATH 261 Engineering Mathematics III 3 Credits
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): MATH 162, MATH 162

This course covers advanced multivariable calculus and vector analysis. Topics include vectors in 3D, equations of lines and planes, vector functions, and space curves. Students study derivatives and integrals of vector-valued functions, exploring concepts like arc length and curvature. Functions of several variables, including partial derivatives, are examined, with applications like tangent planes and gradients. Integration techniques cover double and triple integrals, coordinate systems, and variable changes. Line and surface integrals, along with fundamental theorems such as Green's, Stokes', and Divergence, are introduced, highlighting applications in physics and engineering. Prerequisite: MATH 162.

MATH 318 Differential Equations **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): MATH 261, MATH 261

This course provides a comprehensive exploration of differential equations and their applications. Topics include direction fields, solution methods such as separation of variables and Laplace transforms, and classification of equations. Students analyze linear and nonlinear equations, autonomous equations, and systems of equations. Techniques for solving homogeneous and nonhomogeneous equations, including mechanical and electrical applications, are covered. Special focus is placed on Laplace transforms for solving initial value problems and convolution integrals. Additionally, numerical methods like Euler's method and Runge-Kutta method are introduced for approximating solutions. Emphasis is on understanding theoretical concepts and applying them to diverse real-world scenarios. Prerequisite: MATH 261.

MATH 321 Topics in Applied Mathematics **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): MATH 261

This course offers a comprehensive study of linear algebra and its applications Topics include solving systems of linear equations using Gaussian elimination and matrix operations, along with determinants and their properties Students delve into vector spaces, subspaces, and linear transformations, exploring concepts such as rank, nullity, and change of basis Eigenvalues, eigenvectors, and diagonalization are covered extensively, alongside orthogonal projections and least squares methods. Additionally, the course introduces inner product spaces, orthogonalization techniques, and applications like Green's theorem and Stokes' theorem Emphasis is on understanding theoretical concepts and their practical applications in various fields including physics, engineering, and computer science.

Mechanical Engineering

MEEN 210 Computer Aided Design **2 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): ENGR 110, Grade C or better in ENGR 110

Introduction to geometric modeling for mechanical design using modern computer-aided design (CAD) and prototyping tools; covers systematic design methodology, geometric visualization (orthographic, isometric, oblique, and perspective), and three-dimensional modeling (surface and solid representations); includes dimensioning, tolerancing, and rapid prototyping with 3D printing. Prerequisite: Grade C or better in ENGR 110.

MEEN 223 Principles of Engineering Materials **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): CHEM 127 and PHYS 216 and CHEM 128, CHEM 127, CHEM 128, and PHYS 216

Structures of metals, polymers, ceramics, and composites; structure-property relationships and their impact on material performance; defects and diffusion in materials; mechanical, thermal, electrical, magnetic, and optical properties of materials; fundamental structure–property–processing relationships; emphasis on phase diagrams, deformation mechanisms, and performance in engineering applications. Prerequisites: CHEM 127, CHEM 128, and PHYS 216.

MEEN 225 Statics **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): PHYS 216, PHYS 216; MATH 261 or concurrent enrollment

Application of the laws of classical mechanics to simplified, plausibly real-world problems or interest to mechanical engineering, including the equilibrium analysis of frames, trusses, beams, machines and mechanisms, internal forces; basics of stress analysis in axially loaded members and beams. Prerequisites: PHYS 216; MATH 261 or concurrent enrollment.

MEEN 260 Measurement and Instrumentation **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

Introduction to the basic instrumentation and experimental methodology in mechanical engineering data acquisition and signal processing; introduction to various types of sensors, principles of operation, use, calibration, precision, and accuracy; statistical data analysis, and interpretation and reporting of results. Prerequisites: STAT 211; ELEN 215 or concurrent enrollment.

MEEN 263 Dynamics **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): MEEN 225 and MATH 261, MEEN 225, MATH 261

Dynamics of particles, system of particles and rigid bodies, rectilinear and curvilinear kinematics, Newtonian mechanics, principles of work and energy, and impulse-momentum relationships, kinematic analyses and equations of motion for diverse mechanical systems, analytical and numerical solution of equations of motion using modern software, In-lecture demonstration simulation, and experimental studios to strengthen the understanding concept of mechanical dynamic systems. Prerequisites: MEEN 225, MATH 261.

MEEN 305 Mechanics of Materials **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): MEEN 225 and MEEN 223, MEEN 223, MEEN 225

Applications of stress and deformation relationships for deformable bodies and mechanical elements relevant to mechanical engineers; to include axially loaded members, stability of columns, torsional members and beams, combined loadings, and introduction to structural design. Prerequisites: MEEN 223, MEEN 225.

MEEN 315 Engineering Thermodynamics **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): CHEM 127 and MATH 162 and PHYS 216

Theory and application of energy methods in engineering; conservation of mass and energy; energy transfer by heat, work, and mass; thermodynamic properties; analysis of open and closed systems; phase behavior and equations of state, the second law of thermodynamics and entropy; gas, vapor and refrigeration cycles. Pre/Co-requisite(s): CHEM 127, PHYS 216, and MATH 162

MEEN 344 Fluid Mechanics **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): MEEN 315 and MATH 318

Application and the laws of statics, buoyancy, mass, momentum, and energy to the behavior of ideal and real fluids; conservation laws, laminar and turbulent flow in compressible and incompressible flows, Reynolds number, Moody diagram, dimensional analysis and similitude and their application to flow through ducts, pipe, and pumps; lift and drag, fundamental principles of boundary layers. Pre/Co-requisite(s): MEEN 315, MATH 318

MEEN 345 Fluid Mechanics Laboratory **1 Credit**
Grade Mode: Standard Letter
Prerequisite(s): MEEN 260

Introduction to basic fluid mechanics instrumentation; experimental verification and reinforcement of the analytical concepts introduced in MEEN 344 . Pre/Co-requisite(s): MEEN 260; MEEN 344 or concurrent enrollment

MEEN 357 Computational Methods in Mechanical Engineering **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): MATH 318, MATH 318

Practical foundations for the use of numerical methods to solve engineering problems: Review of Python programming; Taylor series, error estimation, numerical solution of non-linear algebraic equations, numerical solution of linear systems of equations and linear eigenvalue problems; numerical integration and differentiation; least-squares curve fitting and interpolation, numerical solution of ordinary differential equations (initial value and boundary value problems); finite difference methods for parabolic and elliptic partial differential equations; Introduction to the finite element method; Implementation and debugging of various numerical methods in Python codes. Prerequisite: MATH 318.

MEEN 360 Manufacturing of Engineering Materials **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): MEEN 223, MEEN 223

An extension of the fundamental understanding of the structure - property relationship of materials; microstructure production and control; manufacturing processes for producing various classes of engineering materials including machining and additive technologies, design considerations for materials and manufacturing processes selection. Prerequisite: MEEN 223.

MEEN 361 Manufacturing of Engineering Materials Laboratory **1 Credit**
Grade Mode: Standard Letter
Prerequisite(s): MEEN 210 and MEEN 260, MEEN 210, MEEN 260; MEEN 360 or concurrent enrollment

Experiments in materials characterization and manufacturing processes; emphasis on mechanical properties of materials; microstructure production and control; manufacturing processes for producing various shapes for components and structures for different classes of engineering materials. Prerequisites: MEEN 210, MEEN 260; MEEN 360 or concurrent enrollment.

MEEN 363 Mechanical Vibrations **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): MEEN 263 and MATH 318, MEEN 263, MEEN 318; MEEN 260 or concurrent enrollment

Free and forced vibration of single and multiple degree-of-freedom systems; distributed parameter systems; development and application of mathematical methods and computational tools for modeling, analysis, and design of vibrating systems; introduction to vibration testing experimental modal analysis; practical engineering applications. Prerequisites: MEEN 263, MEEN 318; MEEN 260 or concurrent enrollment.

MEEN 364 Dynamic Systems and Controls **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): MEEN 363 and ELEN 215, MEEN 363, ELEN 215

Mathematical modeling and analysis of different types of dynamic systems; introduction to feedback control, time and frequency domain analysis of control systems, stability, PID control, root locus; design of computer-based controllers. Prerequisites: MEEN 363, ELEN 215.

MEEN 365 Dynamic Systems and Controls Laboratory **1 Credit**
Grade Mode: Standard Letter
Prerequisite(s): MEEN 260, MEEN 260; MEEN 364 or concurrent enrollment

Introduction to basic control systems instrumentation; experimental verification of control system concepts; implementation of computer-based controllers; data acquisition and analysis. Prerequisites: MEEN 260; MEEN 364 or concurrent enrollment.

MEEN 368 Design of Mechanical Components and System I **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): MEEN 305, MEEN 305

Design for stiffness and stability (Internal forces and deflections using singularity functions, Deflections of straight and curved members, statically indeterminate beams, buckling design of columns and frames); Design for strength (stress analysis in 3D, Strength design to avoid static failure, Strength design to avoid failure under variable loading); Design of mechanical components and assemblies (design for strength and stiffness concepts to mechanical components and assemblies, Analysis of shafts with gears using singularity functions, Analysis of tension-loaded bolted and welded joints). Prerequisite: MEEN 305.

MEEN 381 Seminar **1 Credit**
Grade Mode: Standard Letter

Presentations by practicing engineers, professionals, and faculty members addressing effective communications, engineering practices, professional registration, ethics, career-long competence, contemporary issues, impact of technology on society and being informed; preparation of a resume, a lifelong learning plan, two papers, two oral presentations and complete an online assessment of the mechanical engineering program. Prerequisite: Major in mechanical engineering.

MEEN 391 Internship **0 Credits**
Grade Mode: Pass/Non Pass

Participation in an approved high-impact learning practice, such as engaging with industry, research entities, or startup companies.

MEEN 401 Senior Design Project I **3 Credits**
Grade Mode: Standard Letter
Prerequisite(s): MEEN 360 and MEEN 361, MEEN 360, MEEN 361; MEEN 364, MEEN 365, MEEN 368, MEEN 461, MEEN 464 or concurrent enrollment

The design innovation process; needs definition, functional analysis, performance requirements and evaluation criteria, conceptual design evaluation, down-selected to an embodiment; introduction to systems and concurrent engineering; parametric and risk analysis, failure mode analysis, material selection, and manufacturability; cost and life cycle issues, project management. Prerequisites: MEEN 360, MEEN 361; MEEN 364, MEEN 365, MEEN 368, MEEN 461, MEEN 464 or concurrent enrollment.

MEEN 402 Senior Design Project II **3 Credits**
Grade Mode: Standard Letter
Prerequisite(s): MEEN 401, MEEN 401

. Product detail design and development process including case studies; project management, marketing considerations, manufacturing, detailed design specifications; failure modes, application of codes and standards, selection of design margins; product (component) development guidelines; intellectual property, product liability, and ethical responsibility. Prerequisites: MEEN 401.

MEEN 404 Design of Experiments for Engineering Applications **3 Credits**
Grade Mode: Standard Letter
Prerequisite(s): MEEN 361, MEEN 360, MEEN 361; MEEN 364, MEEN 365, MEEN 368, MEEN 461, MEEN 464 or concurrent enrollment

Systematic design of experimental investigations; student teams identify topics and develop experiment designs including establishing the need; functional decomposition; requirements; conducting the experiment; analyzing and interpreting the results and written and oral reports documenting the objectives, procedure, analysis, and results and conclusion of two or three experiments. Prerequisites: MEEN 360, MEEN 361; MEEN 364, MEEN 365, MEEN 368, MEEN 461, MEEN 464 or concurrent enrollment.

MEEN 421 Thermal-Fluids Analysis and Design **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): MEEN 461

Integration of thermodynamics, fluid mechanics and heat transfer through application to the design of various thermal systems comprised of several components requiring individual analyses; analysis of the entire system; representative applications of thermal-fluids analysis with a design approach. Pre/Co-requisite(s): MEEN 461; or approval from the instructor.

MEEN 423 Machine Learning for Mechanical Engineers **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): MEEN 357, MEEN 357

Machine learning techniques with applications to the analysis and design of mechanical, fluid, thermal, material and multidisciplinary systems; linear and kernel support vector machines; neural networks; Bayesian techniques; decision trees and random forests; dimension reduction and model selection; data management and learner validation strategies; tools and application studies. Prerequisite: MEEN 357

MEEN 433 Principles of Mechatronics **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): MEEN 364, MEEN 364

Introduction to mechatronics; basic principles of digital logic and analog circuits in mechanical systems; electrical-mechanical interfacing; sensors and actuators; digital control implementation; precision design and system integration. Prerequisite: MEEN 364.

MEEN 435 Automation and Robotics **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

Industrial robotics with a focus on applications. This includes kinematics and programming of industrial robots, robotic welding, robotic assembly, and other industrial applications. Computer vision for use in robotic systems is an important area. Industrial computer systems for the implementation of robotic manufacturing systems, and mechatronics. Automation for offshore applications with a focus on top-side automation for drilling platforms and control systems for subsea production systems for oil and gas. Prerequisite: Senior Standing

MEEN 441 Design of Mechanical Components and Systems II **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

Basics of finite element analysis of trusses and beams under static and dynamic loading; Review of failure theories due to static loading; Review of fatigue failure theories due to variable loading; Shaft design; Design of bolted joints; Design of welded joints; Gear design; Design of springs; Design of flexible mechanical elements (belts); Simulation studios using engineering software such as SAP2000, ANSYS and MSC/ADAMS. Prerequisites: MEEN 368.

MEEN 444 Finite Element Analysis **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): MEEN 357 and MEEN 368, MEEN 357; MEEN 368

Physical FEM with applications to bars, trusses and beams; Mathematical FEM: Integral formulations and variational method; Second-order boundary value pbs in 1-D: Finite Element Models & Applications; Fourth-order boundary value pbs in 1-D: Beams and Frames; Dynamic eigenvalue problems of trusses and beams; Dynamic analysis of rotating rotors; Computer implementation of 1-D problems in Python (bars, trusses and beams); Aspects of finite element modeling of 1-D problems; Single-variable problems in 2-D (temperature distribution in a plate); Size optimization in structures using FEA; Theory and applications of finite element updating; Simulation studios using SAP2000, ANSYS and FEMTOOLS. Prerequisites: MEEN 357; MEEN 368.

MEEN 453 Advanced Manufacturing Processes **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): MEEN 360 and MEEN 361, MEEN 360; MEEN 361

Machining theory; traditional and non-traditional machining processes; CNC machines and tools; geometric dimensioning and tolerance (GD&T); additive manufacturing systems and processes; materials in additive manufacturing. Prerequisites: MEEN 360; MEEN 361.

MEEN 460 Corrosion Engineering **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): MEEN 360 and MEEN 361, MEEN 360; MEEN 361

Basic corrosion phenomena are described, identification of corrosion types and application of mixed potential theory, kinetics, and thermodynamics; methods for measuring corrosion rates and employing corrosion control strategies through design strategies, inhibitors, coatings and cathodic protection. Prerequisites: MEEN 360; MEEN 361.

MEEN 461 Heat Transfer **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): MEEN 344

Heat transfer by conduction, convection and radiation: steady and transient conduction, forced and natural convection, blackbody and gray body radiation; multi-mode heat transfer; boiling and condensation; heat exchangers. Pre/Co-requisite(s): MEEN 344

MEEN 464 Heat Transfer Laboratory **1 Credit**
Grade Mode: Standard Letter
Prerequisite(s): MEEN 345

Basic measurement techniques in conduction, convection, and radiation heat transfer; experimental verification of theoretical and semi-empirical results; uncertainty analysis. Pre/Co-requisite(s): MEEN 345; MEEN 461 or concurrent enrollment.

MEEN 467 Mechanical Behavior of Materials **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): MEEN 360 and MEEN 361, MEEN 360; MEEN 361

Fundamentals of flow and fracture in metals, emphasizing safe design by anticipating response of materials to complex stress and environmental service conditions; micromechanisms of flow, fatigue, creep and fracture; fracture mechanics approach to design; special emphasis given to microstructure-mechanical property relationship and damage tolerant design. Prerequisites: MEEN 360; MEEN 361.

MEEN 470 Principles of Energy Conversion **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): MEEN 461

The Principles of Energy Conversion course introduces the fundamentals of thermodynamics, heat transfer, and fluid mechanics as applied to energy systems. It covers analyzing and optimizing conventional systems like fossil fuel engines and power cycles (Rankine, Brayton), renewable technologies (solar, wind, geothermal), and advanced systems such as fuel cells and thermoelectric generators. The course emphasizes computational modeling and the socio-economic impact of energy technologies, equipping students with tools to design and optimize modern energy solutions. Pre/Co-requisite(s): MEEN 461

MEEN 472 Building Science, Technology, and HVAC Systems **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): MEEN 461

In this course, students will explore the fundamental principles of building science, including heat transfer, moisture control, and air movement, to design energy-efficient and sustainable buildings. Key topics include the integration of HVAC systems, indoor air quality, thermal insulation, the basic principles of building enclosure design, including the design of walls and roofs, and acoustics are examined. Case studies and hands-on projects will provide practical experience in developing solutions that optimize building performance for sustainability and occupant comfort. Pre/Co-requisite(s): MEEN 461; or approval from the instructor

MEEN 473 Advanced Natural Gas Engineering and Handling Equipment **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

Natural gas well production and deliverability fundamentals, process description and design aspects of gas processing facilities including inlet separation operations, flow assurance challenges including multiphase flow, hydrate prevention and control, gas dehydration, gas transmission and transportation systems, natural gas handling equipment with the aid of ANSYS and HYSYS. Pre/Co-requisite(s): MEEN 315, MEEN 344; or approval from the instructor

MEEN 474 Sustainable Energy Technologies and Systems **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): MEEN 461

This course will introduce students to the fundamentals of sustainable energy technologies, focusing on key renewable energy sources such as solar, wind, hydro, tidal, geothermal, biomass, CCUS, ammonia, and hydrogen. It will explore the principles, applications, and integration of these technologies into modern energy systems. Through lectures, case studies, and hands-on exercises, students will gain insights into the design, operation, and socio-economic implications of renewable energy solutions. Emphasis is placed on practical skills development and real-world applications, equipping students to contribute effectively to the global transition towards a more sustainable and resilient energy future studying the transition to a low-carbon economy. Pre/Co-requisite(s): MEEN 461; or approval from the instructor

MEEN 489 Selected Topics in Mechanical Engineering **1-3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

Advanced or applied topics in mechanical engineering offered according to student's interest and availability of instructors and equipment. Lecture hours, laboratory, and/or computation period to be arranged.

Physics

PHYS 216 Newtonian Mechanics for Engineering and Science **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): MATH 161

Newtonian Mechanics for Engineering and Science, is the first semester of a two-semester sequence in introductory physics, intended to introduce students to the basic principles of Newtonian mechanics and harmonic motion. We will cover topics in mechanics, Newton's Laws, the concepts of energy and work, conservation of energy and momentum, rotational motion, gravity, harmonic motion and waves. The course is taught with lectures, recitations and in-class participation. The material is presented at a level that requires significant algebra and trigonometry, as well as some basic calculus.

PHYS 217 Electricity and Magnetism for Engineering and Science **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): PHYS 216 and MATH 162 and PHYS 226

Electricity and Magnetism for Engineering and Science is a continuation of the course on Mechanics, introduces concepts and laws by which electric, magnetic, and optical phenomena can be described and analyzed both quantitatively and qualitatively. This is an advanced physics course substantially based on calculus tackling electricity and magnetism; electromagnetic phenomena; basic laws of electricity and magnetism; science and engineering problems involving charges, electromagnetic fields, and electrical circuits. The course is taught with lectures, recitations and in-class participation.

PHYS 226 Experimental Physics and Engineering Laboratory I: Mechanics **1 Credit**
Grade Mode: Standard Letter
Prerequisite(s): MATH 161

Newtonian Mechanics for Engineering and Science, is the first semester of a two-semester sequence in introductory physics, intended to introduce students to the basic principles of Newtonian mechanics and harmonic motion. We will cover topics in mechanics, Newton's Laws, the concepts of energy and work, conservation of energy and momentum, rotational motion, gravity, harmonic motion and waves. The course is taught with lectures, recitations and in-class participation. The material is presented at a level that requires significant algebra and trigonometry, as well as some basic calculus.

PHYS 227 Experimental Physics and Engineering Laboratory II: Electricity and Magnetism **1 Credit**
Grade Mode: Standard Letter

This course focuses on the description and application of the laws of electromagnetism to the solution of science and engineering problems. During most bi-weekly projects, students are introduced to a variety of sensors and their basic calibration, and students will program the computer-based data-acquisition and control framework. Using sensing, control and actuation these lab projects target experimental verification of the physics concepts while solving direct engineering problems.

Sports and Entertainment

SPTE 590 Special Topics in Sport and Entertainment **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

This course investigates special topics pertinent to the sport and entertainment management industry, and specifically examines in detail the concept of mega-event sport tourism. It examines mega-event sport tourism from both the sport and entertainment and hospitality and tourism sectors; including managaement of the Olympic Games, theories that may explain willingness to support the Olympic Games as a sport tourism mega-event and impacts of sport tourism mega-events in a geopolitical arena.

SPTE 612 Sport Governance **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

This course is designed to examine how sport organizations operate, emphasizing, however, on how sport organizations are expected to operate. This more normative approach is facilitated by references to principles of good governance, i.e., transparency, accountability, democracy and social responsibility. The student will learn about the main theoretical approaches underpinning governance, as well as the main governance challenges facing the sport sector, including the impact poor governance and lack of accountability can have on different types of sport organizations.

SPTE 640 Venue Management: Principles and Practices **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

The course examines the principles and practices associated with managing a public assembly venue (PAV) and the nature of the PAV business. The emphasis will be on assisting the student in understanding the concepts and related to this relatively new professional field. The course examines the types of issues that venue managers must consider, together with gaining some practice in applying concepts and principles to those issues.

SPTE 670 Special Topics in Global Sport **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

This course investigates special topics pertinent to the sport and entertainment management industry, and specifically examines the critical role a of broadcasting in the economy of the sport and entertainment industry. The course explores the various models for broadcasting rights, the political economy of sport broadcasting, and its contemporary developments. The course addresses the complex interactions between competition at local, regional and transnational levels.

SPTE 701 Management in the Sport and Entertainment Industry **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

This course examines the concepts and principles of management and the role of management in the sport and entertainment industry. The course examines different management theories, management functions and leadership styles, while applying concepts and principles to current management issues in the sport and entertainment industry.

SPTE 736 Sport Event Entrepreneurship **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

This course investigates the entrepreneurial process and relates this process to the creation of a sport/entertainment event. Students will identify, describe and utilize identifiable techniques to generate ideas, conduct feasibility analyses, identify and utilize the 4 Ps of marketing to outline and develop a business plan for a chosen sport/entertainment event.

SPTE 760 Principles of Sport and Entertainment Marketing 3 Credits
Grade Mode: Standard Letter

This course examines the theoretical and practical aspects of sport and entertainment marketing including its dynamic nature and the importance of branding. It aims to provide an understanding of the importance of marketing and consumer behavior theory and fundamentals specific to the marketing of sport and entertainment. The course introduces students to marketing within the sport and entertainment industry, including the unique aspects of sport and entertainment as product, the sport and entertainment consumer market and the sport product market.

SPTE 777 Sport and Events Logistics 3 Credits
Grade Mode: Standard Letter, Audit/Non Audit

This course brings together the strategic, planning, and operational roles of logistics when applied to sport and entertainment management. The aim is the gain knowledge on how to apply logistics models and methods for the optimal management of personnel, facilities and flows involved in sport and entertainment events.

SPTE 781 Seminar on the Olympic Games 3 Credits
Grade Mode: Standard Letter, Audit/Non Audit

This course investigates special topics pertinent to the sport and entertainment management industry, and specifically examines in detail the concept of mega-event sport tourism. It examines mega-event sport tourism from both the sport and entertainment and hospitality and tourism sectors; including management of the Olympic Games, theories that may explain willingness to support the Olympic Games as a sport tourism mega-event and impacts of sport tourism mega-events in a geopolitical arena.

SPTE 790 Sport and Entertainment Finance 3 Credits
Grade Mode: Standard Letter, Audit/Non Audit

The course examines the concepts and principles of financial management, and its application within the sport and entertainment context. The course provides an understanding of the financial information necessary to perform the usual duties and responsibilities associated with sport facilities, programs and organizations.

SPTE 798 Directed Study in Sport and Entertainment Management 3 Credits
Grade Mode: Standard Letter, Audit/Non Audit

This course is a course that focuses on a special project/ study and/or research undertaken Directedly by the student. Students are expected to embark on a project and/or study focusing on a particular aspect of sport and entertainment management, and is related to his or her special interest. Students are expected to undertake a set of activities, as agreed upon, based on the topic under study.

SPTE 799 Thesis Preparation 1-6 Credits
Grade Mode: Pass/Non Pass

Sustainability Studies

SENS 601 Research Methods and Ethics 3 Credits
Grade Mode: Standard Letter, Audit/Non Audit

The course prepares students for performing graduate level research. It introduces students to quantitative and qualitative methods for critical exploration of research, locating and summarizing and critiquing relevant literature, developing a research problem, framing a problem with an appropriate research method, constructing a coherent research designs. Introduction to ethics and ethical misconduct, intellectual property and environmental health and safety. Through the course students will be developing a research proposal.

SENS 611 Sustainability Fundamentals and Tools 3 Credits
Grade Mode: Standard Letter, Audit/Non Audit

This course gives a general introduction to sustainability and how this concept evolved from the environmental movement of the post-World Water 2 era to the present. It outlines the major global issues that sustainability confronts, the major stakeholders involved and the barriers that prevent the wide scale application of sustainability principles. Students will be introduced to the main methods of quantifying sustainability, assessing the strengths and limitations of each method.

SENS 681 Integrated Sustainable Design for the Built Environment 3 Credits
Grade Mode: Standard Letter, Audit/Non Audit

Students gain principles of sustainable design, and implement, demonstrate and debate them for specific built-environment projects in teams.

SENS 695 Master's Thesis Hours 1-6 Credits
Grade Mode: Pass/Non Pass

The student formulates and undertakes an independent scientific research project under the supervision of their research adviser. A successful thesis defence leads to a Pass grade.

SENS 698 Industrial/Applied Project 6 Credits
Grade Mode: Standard Letter, Pass/Non Pass

The student formulates and undertakes an independent scientific research project under the supervision of their research adviser. A successful thesis defence leads to a Pass grade.

SENS 701 Research Seminars 0 Credits
Grade Mode: Audit/Non Audit, Pass/Non Pass

Research seminars are a regular slot for invited speakers and students to present scientific research and be listen to Sustainability related topics outside their main research focus.

SENS 706 Independent Studies 3 Credits
Grade Mode: Standard Letter

Independent studies offer an opportunity for students to perform independent research work in any area related to Sustainable Development under the supervision of a faculty member

SENS 712 Environmental Quality and Health **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

The course will provide an overview on the relationship between Environmental Quality and health and the link to economic growth and sustainable development. Case studies will demonstrate the importance of growth, expansion of urban population and their impact on land, and water resources quantity and quality. In addition the course will cover the risks, transport and toxicity mechanisms associated with Chemicals of Emerging Concern in daily life, industry, and drinking water.

SENS 714 Sustainability: Energy, Environment and Economics **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

This course provides an introduction to the interactions between energy, environment, economics and society, and how these impact sustainable development. The course will explore the influence of society through population growth, changing consumption rates and a desire to grow GDP on the extraction and utilization of energy sources and related environmental impacts. In particular the course will focus on the economic and social impacts of renewable energy development and environmental resource management.

SENS 715 Life Cycle Assessment - LCA **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

The need for sustainable engineering is fueling the development of novel tools and techniques for studying the behavior of industrial systems and their relationship with the biosphere and society. Life Cycle Assessment (LCA) is an environmental modeling method that has become increasingly popular within business and academia for evaluating the environmental impacts of products or systems. LCA considers impacts along the entire life cycle, from production to consumption to disposal, and generally provides quantitative information for a range of different environmental issues to inform decisions. This course enables students to develop a practical understanding of the intellectual foundation and standards of LCA, common databases and software packages used, and their application to products and systems. Process-based analysis models, input-output and hybrid approaches are presented for LCA. This is a research based course and is suitable for students interested in researching in depth a particular topic.

SENS 716 Efficiency: Resource Use and Behavioural Analysis **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

This course explores the various uses of energy and other resources in a variety of human activities, the relative magnitudes of resource consumption and waste and the technological, social and economic factors that impact energy and resource efficiency and conservation.

SENS 718 Sustainable Cities and Urban Mobility **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

This course offers a multidisciplinary exploration of sustainable urban development by integrating advanced energy systems and smart city frameworks with traditional urban planning and transportation studies. Students will analyze the interplay between urban design, mobility, and public health alongside topics such as energy and sustainability. Building on established smart city frameworks, the course incorporates a smart city matrix that assesses urban progress through seven sub-indexes—Smart Environment, Smart Economy, Smart Society, Smart Governance, Smart Energy, Smart Infrastructure, and Smart Transportation—allowing students to quantify a city's transition toward sustainability.

SENS 719 Energy Water Food (EWF) Nexus **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

This course investigates the nexus of energy, water and food (EWF) resources and the complex interaction with human behavior and natural systems, in addition to the inter-dependencies that exist between the EWF resources themselves. The social, technical and economic nature of these interdependencies is explored throughout the life cycle of various systems to determine optimal solutions for a sustainable future.

SENS 720 Additive Manufacturing for Sustainability **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

This course focuses on Additive Manufacturing and the relevant issues of materials, design, process, applications, modelling and simulation. It will introduce the fundamental concepts, its relevance, use and importance under the field of sustainability in terms of materials, time, space and resource efficiency; part, process and application flexibility; distributive, on-time and on-demand nature of production capability; and possible intertwining with other disciplines of materials science, design, industry, production, arts and architecture. Then, it will gain knowledge on various emerging types, approaches, applications of Additive Manufacturing in addition to materials, design, modelling and economics for it.

SENS 721 Advanced Materials Synthesis and Characterization **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

This course provides an overview and hands on experience on processing and characterization techniques of advanced materials used in energy, water, and electronics applications. Both chemical and physical processes to synthesize and deposit materials in various scales including nanostructures, thin films and bulk are tackled. The course also provides basic training in advanced characterization technics such as AFM, SEM, XPS, TOF-SIMS, XRD, Raman and FTIR. In addition, advanced tools related to PV characterization (e.g. TRPL, PL mapping and micro PCD) will be as well introduced in-depth

SENS 722 Sustainable Chemical Industry - A Green Approach **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

This course will introduce principles and practices of sustainable chemical process design to reduce industry's impact on the environment. Specific examples will cover the possibilities of running industrial chemical processes in a sustainable manner and provide an up-to-date insight into the main concerns for sustainable process optimization.

SENS 728 Electrochemistry and Environmental Corrosion 3 Credits
Grade Mode: Standard Letter, Audit/Non Audit

This course is designed for graduate students who are interested in learning by doing in the area of applied electrochemistry and environmental corrosion. The course specifically focuses on how to make electrode and cells (e.g., battery). Also, the course extends to study corrosion behavior of metallic substrates under a given condition that develop in our living environment. Furthermore, the course teaches advanced techniques used to understand electrode reactions in particular corrosion processes and estimate important parameters, such as corrosion potential and corrosion rates.

SENS 729 Electrochemistry and Electrochemical Processing 3 Credits
Grade Mode: Standard Letter, Audit/Non Audit

This course is about introducing fundamentals and applications of electrochemisty in energy storage

SENS 762 Advanced Transport Phenomena 3 Credits
Grade Mode: Standard Letter, Audit/Non Audit

This course will acquaint the student with important topics in advanced transport phenomena (momentum, heat and mass transport). Topics include laminar and turbulent flow, thermal conductivity and the energy equation, molecular mass transport and diffusion with heterogeneous and homogeneous chemical reactions. Focus will be to develop physical understanding of principles discussed and with emphasis on different field of engineering applications. In addition to the text, the student will be exposed to classic and current literature in the field. Two exams, homework assignments and a student project are required

SENS 780 Green Building: Design, Construction and Operation 3 Credits
Grade Mode: Standard Letter, Audit/Non Audit

The built environment is a major source of environmental impact. This course teaches all major aspects of green building design, construction and operation with life cycle thinking in order to reduce these impacts. All green building categories are covered: location & transportation, sustainable sites, energy and atmosphere, water efficiency, materials & resources, and indoor environmental quality. The United States Green Building Council's LEED rating system is used to demonstrate one possible green rating system.

SENS 785 Innovation Entrepreneurship Leadership I 3 Credits
Grade Mode: Standard Letter, Audit/Non Audit

This course first provides introductory discussions on theories of design innovation, entrepreneurship and leadership. Then, it focuses on experiential learning for design and development of products, processes, systems and business models. Topics include design thinking, system thinking, design process; understanding and developing user/stakeholder needs/input for a sustainable solution; generating technical and marketing specifications; and prototyping methods to reduce development time.

SENS 786 Innovation Entrepreneurship Leadership II 3 Credits
Grade Mode: Standard Letter, Audit/Non Audit

This course first provides introductory discussions on theories of design innovation, entrepreneurship and leadership. Then, it focuses on experiential learning for design and development of products, processes, systems and business models. Topics include design thinking, system thinking, design process; understanding and developing user/stakeholder needs/input for a sustainable solution; generating technical and marketing specifications; and prototyping methods to reduce development time.

SENS 791 Geospatial Information Systems 3 Credits
Grade Mode: Standard Letter, Audit/Non Audit

This course is about introducing information system fundamentals for geospatial applications

SENS 890 Dissertation Hours 1-9 Credits
Grade Mode: Pass/Non Pass

Original and independent doctoral thesis research. A successful defense of the thesis leads to the grade Pass

Sustainable Energy

SENR 615 Oil and Gas Geopolitics 3 Credits
Grade Mode: Standard Letter, Audit/Non Audit

This course focuses on geopolitical aspects of the oil and gas industry starting with an introduction of history of oil and gas and the geopolitics. It provides a global understanding of sources of crude oil and natural gas; current statistics of oil and gas reserve and production; economic analysis and environmental impacts of the oil and gas industry; finance and current market share; the future of this fossil fuel industry versus sustainable energy resources.

SENR 724 Solid State Physics 3 Credits
Grade Mode: Standard Letter, Audit/Non Audit

The course covers the physics concepts that describe the electrical, optical and thermal properties of materials and their energy related applications as well as some of the advanced techniques that are used to study these properties. Course topics include: (i) Perfect crystals and defects, (ii) electronic properties, (iii) Optical properties, (iv) thermal properties, (vi) Properties of Nanomaterials.

SENR 727 Science and Engineering of Thin Films and Interfaces 3 Credits
Grade Mode: Standard Letter, Audit/Non Audit

It introduces fundamentals of thin films and their appications in solar PV

SENR 740 Energy Resources, Generation, Science and Technology 3 Credits
Grade Mode: Standard Letter, Audit/Non Audit

It introduces comparatively basic technology and economic aspects of various enenergy resource technologies

SENR 741 Oil and Gas Technology and Economics **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

This course focuses on various aspects of the oil and gas industry; the history of oil and gas and the geopolitics of the industry; sources of crude oil and natural gas; current statistics of oil and gas reserve and production; the process from extraction to consumer delivery (Well to Wheel); natural gas in Qatar; natural gas processing, transport, and storage; economic analysis and environmental impacts of the oil and gas industry; petroleum finance and current market share; the future of this fossil fuel industry versus sustainable energy resources.

SENR 742 The Life Cycle of Oil and Gas Fields **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

This course focuses on the life cycle of an oil and gas fields; specifically, the upstream component. It discusses the technical, theoretical and operational aspects for this component. Drilling technologies and operations, formation evaluations, well testing, and production strategies will be studied. Moreover, it focuses on the recovery mechanisms, enhanced oil recovery, reservoir simulation and management, the life cycle of a well and the abandonment process. Finally, it discusses the environmental effects for this component of the oil and gas industry and how it has decreased over the past decades.

SENR 743 Photovoltaic Solar Technology **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

This course focuses on various aspects of the oil and gas industry; the history of oil and gas and the geopolitics of the industry; sources of crude oil and natural gas; current statistics of oil and gas reserve and production; the process from extraction to consumer delivery (Well to Wheel); natural gas in Qatar; natural gas processing, transport, and storage; economic analysis and environmental impacts of the oil and gas industry; petroleum finance and current market share; the future of this fossil fuel industry versus sustainable energy resources.

SENR 744 Renewable Energy Systems **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

This course is about comparative discussions of renewavle ebergy systems

SENR 750 Energy Storage Devices and Systems **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

This course provides fundamental information about energy storage technologies, applications, and their integration with renewables. This course applies thermodynamic fundamentals to energy storage systems. Furthermore, environmental impacts of energy storage technologies are comparatively presented. The course covers most of the established energy storage technologies and their fundamentals. Energy storage methods considered include; mechanical, thermal, thermochemical, chemical, electrochemical, electromagnetic, biologic and emerging methods.

SENR 754 Smart Power Grids **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

Smart Power Grids course will provide fundamental insights into century long energy studies that aims to match the demand with the supply, as well as a decade long re- search and development efforts in Smart Energy Grids to improve the energy efficiency, reliability, and environmental aspects of the power grids. More specifically, the course will provide a rich introduction to the new multi-disciplinary field of smart grids and it will cover variety of special topics including demand response, advanced metering networks, communication and sensing technologies, distributed energy generation and storage, electric vehicles, wide-area power system monitoring, energy markets, and cyber-security.

SENR 755 Micro-grids: Operation, Management and Planning **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

It is about applications of smart griod technologies for small scale applications

Sustainable Environment

SENV 713 Environmental Impact and Management Systems 3 Credits
Grade Mode: Standard Letter, Audit/Non Audit

This course will review the main sources of pollution and present the methods for assessing their environmental impacts. Impact and management systems will be explored in the context of both local and international environmental legislation; the phases of an EIA; how emission and discharge limits are set; dispersion modelling; risk prioritization; and life cycle analysis. Actual case studies from the process industries will be discussed.

SENV 745 Energy NanoTechnology **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

This course introduces an overview of nanomaterials used for energy production, storage and conservation. The course provides an overview of the synthesis and characterization techniques for nanomaterial used in energy applications such as fuel cells, energy harvesters and energy storage devices.

SENV 760 Air Quality and Climate Change **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

This course introduces important aspects of air quality issues and its relevance to climate change

SENV 761 Atmospheric Chemistry and Climate Change **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

This course provides an exploration of the chemical and physical processes occurring in the near-ground, troposphere and stratosphere including atmospheric composition, structure, transportation and the photochemically driven reactions. In turn students will gain an insight into the role of industrial emissions on smog, ozone depletion and climate change.

SENV 770 Desalination Technologies **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

This course provides an overview of water production in the Gulf Cooperation Council Countries (GCC) through Desalination Processes. The course will explore various technologies including thermal and membrane systems as well as power-cogeneration

SENV 772 Water and Wastewater Treatment **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

This course introduces students to important physiochemical and biological processes in wastewater treatment and the sustainable developments that are occurring in this field. Topics include priority contaminants, water discharge standards and design of suitable treatment processes with a focus on biological treatment of municipal wastewater.

SENV 773 Water Resources Management **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

This course explores the water cycle with a particular focus on hydrology, water conservation, system efficiency, and issues of public health. A range of engineering and social science topics related to water use and management are covered.

SENV 774 Water Treatment and Reuse **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

The course develops graduate level concepts for the examination of drinking water quality and discussion of state of the art technologies for treating drinking water. Case studies will be introduced highlighting the inadequacy or susceptibility to failure of existing drinking water infrastructure to provide students with understanding of what challenges may come across in their professional practice, and how to avoid similar situations in future.

SENV 776 Solid and Hazardous Waste Management **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

This course introduces students to the characterisation, separation, handling and disposal of various wastes from a variety of municipal, construction and industrial sources and explores management and societal issues, treatment/control technologies and resource recovery methods. Methods to eliminate, recover, recycle and re-use wastes are a major focus for this course

SENV 778 Principles of Hydrogeology **3 Credits**
Grade Mode: Standard Letter, Audit/Non Audit

This course introduces students to the fundamentals of hydrogeology and groundwater science. It covers the physical properties of the aquifers, groundwater flow, well hydraulics and groundwater developments, with emphasis on Qatar as a case study. The course also covers basics of groundwater modelling, protection and management.