

COLLEGE OF SCIENCE AND ENGINEERING (CSE)

The College of Science and Engineering (CSE) aims to be a world-class multidisciplinary college with significant positive impact on Qatar, the region, and globally, in the fields of science, engineering, and technology. To accomplish this, we are advancing knowledge and nurturing technically grounded leaders and innovators through teaching and research across a range of carefully targeted programs. The college aims to serve societal needs, with a focus on an integrated multi-disciplinary curriculum and multi-disciplinary research in science and engineering.

For more information, click here (<https://www.hbku.edu.qa/en/cse/about/>).

Programs

- Engineering Management and Decision Sciences (<https://catalog.hbku.edu.qa/academic-degrees/cse/emds/>)
 - Logistics and Supply Chain Management, Master of Science (<https://catalog.hbku.edu.qa/academic-degrees/cse/emds/logistics-supply-chain-management-ms/>)
 - Logistics and Supply Chain Management, PhD (<https://catalog.hbku.edu.qa/academic-degrees/cse/emds/logistics-supply-chain-management-phd/>)
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 - Cybersecurity, Master of Science (<https://catalog.hbku.edu.qa/academic-degrees/cse/ict/cybersecurity-ms/>)
 - Data Science and Engineering, Master of Science (<https://catalog.hbku.edu.qa/academic-degrees/cse/ict/data-science-engineering-ms/>)
 - Electrical Engineering, Bachelor of Science (<https://catalog.hbku.edu.qa/academic-degrees/cse/ict/elec-bs/>)
 - Health Management, Master of Data Analytics (<https://catalog.hbku.edu.qa/academic-degrees/cse/ict/mda-hm/>)
 - Health Management, Master of Information Systems (<https://catalog.hbku.edu.qa/academic-degrees/cse/ict/health-management-mis/>)
- Sustainable Development (<https://catalog.hbku.edu.qa/academic-degrees/cse/sd/>)
 - Chemical Engineering, Bachelor of Science (<https://catalog.hbku.edu.qa/academic-degrees/cse/sd/chem-bs/>)
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Courses

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

This course focuses on the principles of Resistive circuits: circuit laws, Network reduction, nodal analysis, mesh 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 vulnerable 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 accessible 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**CS 440 Distributed Systems****4 Credits**

Grade Mode: Standard Letter, Audit/Non Audit

The goals of this course are twofold: First, for students to gain an understanding of the principles and techniques behind the design of distributed systems, such as locking, concurrency, scheduling, and communication across the network. Second, for students to gain practical experience designing, implementing, and debugging real distributed systems. The major themes this course will teach include scarcity, scheduling, concurrency and concurrent programming, naming, abstraction and modularity, imperfect communication and other types of failure, protection from accidental and malicious harm, optimism, and the use of instrumentation and monitoring and debugging tools in problem solving. As the creation and management of software systems is a fundamental goal of any undergraduate systems course, students will design, implement, and debug large programming projects. As a consequence, competency in both the C and Java programming languages is required.

Computer Science & 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.

Core Science & 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 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.

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 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.

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 107 World History****3 Credits**

Grade Mode: Standard Letter, Audit/Non Audit

This course explores the global past from the emergence of agriculture to the challenges of the contemporary period. Students will examine key events, and themes that have shaped human society, focusing on the interactions and interconnections between various civilizations across time and space. The course places equal emphasis on the histories of the Middle East, East Asia, Africa, and the Western world. Students will develop an understanding of political, economic, social, cultural, and environmental aspects of world history. The course cultivates critical thinking, and historical reasoning enabling students to interpret the complexities of our shared human experience.

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 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

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 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

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

Fulfilling curriculum research requirements.

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 **0-6 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 provides students with a broad and multidisciplinary exploration of sustainable cities and transportation concepts and practices. The course will explore urban planning; mobility issues, their impacts on environment, local climate, air quality and life experiences; and the interdependencies between urban design and human/public health and wellness.

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 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 techniques 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 electrochemistry 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 applications 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 energy 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 renewable energy systems

SENR 750 Energy Storage Devices and Systems

3 Credits

Grade Mode: Standard Letter, Audit/Non Audit

This course is an introduction to the fundamentals and applications of lithium ion batteries, and the classifications of the different cathodes, electrolytes and anodes based on their physicochemical, structural and thermal properties. The course also reviews the electrochemical reactions, kinetics and transport mechanisms, and interfacial phenomena in batteries. Projects dealing with the application of lithium ion batteries for electric vehicles and solar energy will be included.

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 research 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 grid 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.