INFORMATION AND COMPUTING TECHNOLOGY

Programs

- Computer Engineering, Bachelor of Science (https://catalog.hbku.edu.qa/academic-degrees/cse/ict/computer-engineering-bs/)
- Computer Science and Engineering, PhD (https://catalog.hbku.edu.qa/academic-degrees/cse/ict/computer-science-engineering-phd/)
- 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/)

Division 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, 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 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 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

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.

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.

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