

# INFO & COMMUNICATIONS TECHNOL (ICT)

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## **ICT 4000 ICT Business Foundations (4 Credits)**

In this course, students will explore the essential attributes of business research and analysis in the Information and Communications Technology (ICT) field in order to make appropriate business decisions. Students will work in teams to learn about the economic principles that drive the ICT industry, and taking into account industry trends and customer/user needs, will apply the product development process to create a product or service proposal and a business case. Throughout the course, students will have the opportunity to learn and use management and process tools in order to guide the discussion, thinking, and analysis in a structured format. The applicability of these tools extends beyond this course and into the operation and management of an ICT organization.

## **ICT 4005 ICT Technical Foundations (4 Credits)**

This course comprehensively reviews the technological foundations of today's ICT industry. The course will provide students with a technical foundation needed for the ICT program. No technology experience is needed prior to taking the course. Topics include knowledge management, big data, artificial intelligence, information security, cloud computing, and other emerging technologies such as Blockchain. The application development process is also briefly reviewed. The course will provide students with an overview of technologies used to translate data into knowledge. The security requirements associated with a variety of information types are introduced, along with the current best practices used in information security.

## **ICT 4007 Creative Problem Solving and Programming Concepts (4 Credits)**

In this course students will develop, or improve upon, their problem-solving skills. Students will learn to use those problem-solving skills to analyze problems and determine how to create solutions. Students will document their solutions (e.g., in pseudocode or UML diagrams) and, by the end of the course, translate their solutions into running programs written in at least two languages (e.g., Python and C#). Students will learn programming concepts including the use of variables, program input and output, flow control (if-then-else, looping, etc.), and error testing. Students will learn how to set up Integrated Development Environments (IDE) such as X-code and MS Visual Studio on their personal computers in which they will write programs.

## **ICT 4010 Enterprise Architecture (4 Credits)**

In this course, students will learn how to integrate information and communications technologies to effectively and efficiently support business goals. The course examines how enterprise architecture (EA) informs business and technology strategy, including defining, designing, and delivering ICT systems and solutions. The course will explore the basics of EA, such as reference architectures, architecture patterns, and a comparison of EA and other architecture types. Students will also examine the opportunities and limitations of various EA frameworks. Students will apply the methods and tools of one of those frameworks, TOGAF, to design and document an EA initiative. Additionally, EA implications of recent ICT trends such as cloud computing, global privacy and data protection, artificial intelligence, and ICT ecosystems will be explored. Recommended prerequisites: ICT 4000, ICT 4005.

## **ICT 4015 Managing Technology for Strategic Value (4 Credits)**

Technology's impact on business organizations is tremendous, and will likely only intensify in the future. While some businesses still view technology as an expense to the bottom line, other organizations use technology to gain a competitive advantage. Considering the impact of technology on smaller or startup companies as well as large corporations, this course will explore concepts, tools and frameworks to understand how technology can be used to inform business strategy. Students will apply current methodologies to case studies and projects to gain insight into business and digital transformation. Topics include digital future, business organization framework, technology financial management, data proliferation, technology risk management, disruptive innovations, and performance measurement. Prerequisite: Recommended ICT 4000.

## **ICT 4020 Business Forecasting and Planning (4 Credits)**

This course includes a wide diversity of skills required in one's professional career. Topics include the importance of accurate planning and scheduling for successful projects, risk/opportunity analysis, resource planning and allocation, building budgets, revenue forecasting, profit and loss statements, balance sheet analysis, the importance of managing customer perceptions and expectations, and the impact of economic issues on project success. Students will develop business analyses, including budgets and business plans, for several increasingly difficult scenarios addressing a range of technology applications and services. The final case study will culminate in a presentation to be given to potential investors, banks, or venture capitalists to secure a commitment for funding for a simulated telecom project. Recommended prerequisite: ICT 4000.

## **ICT 4025 Technology and Innovation Management (4 Credits)**

Leaders of innovative firms build commitment to new directions, re-design structures to support new missions, and transform cultures. This course concentrates on the implementation of business strategy through effective structures and systems. Students learn why only 7% of companies are able to revitalize their organization once growth has stalled; students also learn what to do about it. Students analyze key aspects of strategic deployment, including organizational structure, cross-functional teams, product development, business model design, and change management. The course concludes with students developing a strategy for implementing an innovation. In this course students integrate the areas of knowledge covered in the ICT Foundations courses and the Technology Management concentration. It should be taken as the last of the four required courses in the Technology Management concentration. Prerequisite: ICT 4000.

**ICT 4045 Information Technology Service Assurance (4 Credits)**

In today's technology-centric work environment, simply delivering IT services is no longer sufficient. Organizations must provide 'assurance' that IT services and the underlying data assets are reliable, highly available and secure. IT Service Assurance or IT Quality Assurance includes many functions including IT service delivery, service level management, quality assurance testing and monitoring, change and release management, project management, security, and compliance, all within a risk management framework. This course evaluates these functions as integrated components of a service assurance program and their impact on the organization. It also investigates how service assurance is intertwined with the strategic and tactical initiatives of the organization. The use of case studies and actual IT related challenges and opportunities are utilized to anchor the course concepts. The combined in-class meetings and online course structure lend itself to ongoing interaction, collaboration, and sharing of ideas.

**ICT 4100 Principles of Project Management (4 Credits)**

This course provides students with practical skills in project management, including project integration, scope (including requirements), time, cost management, and planning human resources. Students will employ various elements of the project management process, software, tools and techniques. Topics include an examination of processes to initiate, plan, execute, monitor and control, and close a project. Students learn project management skills through hands-on exercises, including synchronous group projects.

**ICT 4105 Project Contracts and Procurement (4 Credits)**

This course is designed to provide students with leadership and practical skills in project contracts and procurement. The course covers current trends in the procurement marketplace, including digital transformation, supplier relationship management, sustainability, cyber security and agile processes. Students will gain knowledge of the various elements of the contract and procurement process, including procurement plans, requests for proposal (RFP), Statements of Work (SOW), and various types of contracts. Students will learn project management and negotiating skills, and gain hands-on experience developing a procurement plan, supplier selection criteria, an RFP or other appropriate RFX, and contract terms. Recommended prerequisite: ICT 4100.

**ICT 4110 Project Risk and Quality Management (4 Credits)**

This course introduces students to project risk and quality management and develops advanced skills in applying the project management tools and techniques learned in ICT 4100. A focused examination of scheduling, cost, quality, and risk management processes using advanced tools and techniques is included. Emphasis is placed on the project planning, execution, and monitoring and controlling processes. This course is on the Project Management Institute's (PMI) certification track. Recommended prerequisite: ICT 4100.

**ICT 4115 Project Management Dynamics (4 Credits)**

This is an advanced course that applies the knowledge and skills learned in the prerequisite courses to a complex program. The planning, monitoring and controlling, and project close process groups are explored using case analyses of program and project plans. Learning is based on reading case material and the practical application of project management tools and techniques. Students receive hands on simulation experiences in planning and running subprojects, and work in Project Management Office (PMO) roles. Students develop a workable change management system, exercise project integration and communication skills, and demonstrate the ability to keep an overall program on track. They also demonstrate decision making skills, with emphasis on making tradeoffs based on solid business rationale. This course is on the Project Management Institute's (PMI) certification track. Recommended prerequisites: ICT 4100, ICT 4110.

**ICT 4155 Strategic Alliances in the Technology Sector (4 Credits)**

Strategic alliances are one of the key drivers in today's global economy and they have gradually replaced vertical integration as the chief method of corporate expansion. Business-to-Business alliances provide organizations with a variety of benefits including enhancing the capability of organizations and helping to extract maximum value from available resources. While applicable to any industry, strategic alliances are particularly important in the technology sector. This course defines and discusses the roles of various types of strategic alliances in the technology sector, including informal alliances, partnerships, joint ventures, and outsourcing arrangements. Students will use case studies to explore strategies for managing profitability and leveraging these external business relationships. Students will analyze successful and unsuccessful alliances from the perspective of each alliance participant, 3rd party vendors, customers, and a variety of other stakeholders.

**ICT 4160 Advanced Methods for Complex Projects (4 Credits)**

Advanced Methods for Complex Projects explores the planning and execution challenges that often cause complex projects to fail. This course provides a historical perspective regarding project management practices and reviews evidence regarding trends in project outcomes. Addressing why commonly accepted project management standards and practices are sometimes insufficient to assure project success, the course then explores remedies drawn from recent research and cases in complex systems development and global-teaming case studies. Students will learn and leverage visual modeling and simulation tools for the design of complex projects, applying methods to handle complex, concurrent, and mutual dependencies across organizations and cultures. Through engagement with case studies, students will encounter project design methods, including student access to TeamPort project modeling and simulation software. The course culminates with teams in a role-play exercise to demonstrate collaborative planning and decision-making using these advanced methods. This exercise will require dedicated, synchronous interaction with other team members. Recommended prerequisite: ICT 4100.

**ICT 4170 Agile Techniques and Practices in Project Management (4 Credits)**

Support for implementing Agile project management methods in organizations has surpassed traditional project management methods, particularly in software development. Agile principles and practices are used across many project domains, each with their own unique characteristics and challenges. As the term implies, Agile techniques and best practices for the successful application of Agile project management processes are not static, they are dynamic and will continue to evolve. The Agile debate is now turning from the tactical to the strategic. Realizing the full benefits of Agile (e.g., faster time to market, improved responsiveness to customers, higher quality, and greater efficiency), means more than improving project execution. It requires transforming the business into an Agile enterprise. This course examines both the Agile processes and practices for delivering projects, and the cultural and programmatic challenges encountered in transforming the business into an Agile enterprise. Recommended prerequisite: ICT 4100.

**ICT 4200 Cybersecurity Foundations (4 Credits)**

This course will provide students with an understanding of cybersecurity and the importance of implementing sound cybersecurity policies, procedures, and systems. This course is for students who are new to cybersecurity (e.g., newly appointed managers with little cybersecurity experience) or those who need a refresher on cybersecurity fundamentals prior to taking additional courses in the concentration.

**ICT 4205 Cybersecurity Management (4 Credits)**

This course places students in cybersecurity manager roles to expose them to multiple security viewpoints. Students will interact with the full breadth of cybersecurity dimensions, including people, internal and external organizations, systems, and networks. They will learn how organizations strive to control all possible outcomes and occurrences within defined risk contexts as defined by company Directors. Students walk through the management discipline of cybersecurity in four steps: From the needs, goals, and best practice approaches to the continual maintenance and improvement of an organization's cybersecurity stance. The course will provide students with an understanding of management roles and responsibilities; including, policy and process oversight, adherence to laws and regulations, cybersecurity program management, and understanding the types of reports created and reviewed by cybersecurity managers (such as reports for a Board of Directors). Case studies are used to investigate individual industry leaders from public agencies, standards bodies, and service providers.

**ICT 4210 Cybersecurity Policy (4 Credits)**

This course will help students understand critical events that shaped the U.S. cybersecurity landscape. Students will explore the impact of international cybersecurity policy such as the European General Data Protection Regulation (GDPR) on U.S. businesses. Students will learn how to analyze new cybersecurity policies and regulations to determine their impact on organizations.

**ICT 4215 Cybersecurity Risk Management and Incident Response (4 Credits)**

This course covers how to manage cybersecurity risk including mitigating risk, responding to incidents, and incident reporting (in particular when governmental and regulatory agencies need to be notified). This course will also address working with a public relations team and the Board of Directors to create press statements regarding cybersecurity incidents or breaches.

**ICT 4220 Cybersecurity Leadership and Strategic Planning (4 Credits)**

This course covers the responsibilities of senior and strategic cybersecurity management roles, including the supervision and management of workers performing cyber-related and cyber operations work. The course also covers developing policies and plans, and advocating for changes in policy, that support organizational cyberspace initiatives or required changes and enhancements.

**ICT 4225 Cybersecurity Audits (4 Credits)**

Cybersecurity audits play a key role in addressing today's rapidly changing cyber threat landscape. Executives, including members of the Board of Directors may be required to certify that they have taken reasonable steps to protect information assets. Cybersecurity audits are a primary way to verify that information system and process controls effectively address cybersecurity risks. This course will cover cybersecurity audits, providing aspiring audit professionals with the information needed to manage a comprehensive audit of cybersecurity controls. Recommended prerequisite: ICT 4210.

**ICT 4230 Cybersecurity Training and Education (4 Credits)**

This course will cover the critical importance of the training and education of personnel at all levels of the organization on cybersecurity awareness, including developing, planning, coordinating, delivering and evaluating training courses, methods, and techniques. In the course, students will learn how to influence changing the behavior of insiders and develop a comprehensive security awareness and education plan to help to coordinate, deliver, and evaluate security awareness campaigns.

**ICT 4235 Cybersecurity Procurement and Acquisition Management (4 Credits)**

This course covers data, information, processes, organizational interactions, skills, and analytical expertise, as well as systems, networks, and information exchange capabilities needed to manage acquisition programs throughout the total acquisition life cycle.

**ICT 4300 Web Enabled Information Systems (4 Credits)**

This course is an introduction to the development of modern software systems from the desktop to the cloud. The course examines best practices for software development, introduces database design and object-oriented principles, and covers security issues and best practices related to developing web and cloud applications. The class addresses organizational concerns around web applications, exploitation of technology in today's market, and retention of data integrity. This should be the first course taken in: Software Design and Programming and Web Design and Development. Prerequisite: Recommended ICT 4007 (if student has no prior programming experience).

**ICT 4305 Object-Oriented Methods and Programming I (4 Credits)**

This is the first of two courses that will present Object-Oriented methodologies and programming concepts using the Java programming language. Students will apply Agile tools and techniques, as well as the Unified Modeling Language (UML) within the software development process. The course examines Object-Oriented concepts such as abstraction, encapsulation, generalization, and polymorphism. Students will exercise these concepts with hands-on programming practice and define testing procedures. Additionally, students will use Integrated Development Tools and determine the role of software design frameworks. Recommended prerequisite: ICT 4300.

**ICT 4310 Distributed Computing (4 Credits)**

This course provides a practical, hands-on introduction to distributed applications and the use of cloud technologies. The course develops students' understanding of application scalability, reliability and virtualization through the design, implementation, and deployment of cloud applications and services. Students will evaluate, recommend, and justify distributed technology solutions based on complexity, reliability and cost. Recommended prerequisites: ICT 4300, ICT 4315.

**ICT 4315 Object-Oriented Methods and Programming II (4 Credits)**

This is the second of two courses that will present object-oriented methodologies and programming concepts using the Java programming language. Students will apply Agile tools and techniques, as well as the Unified Modeling Language (UML) within the software development process. The course builds on the material from ICT-4305 to create code based on models written using the UML while applying industry standard object-oriented design patterns. Students will learn critical skills in designing inheritance hierarchies, working with object persistence and serialization frameworks and multi-threaded code. Additionally, the course will cover critical topics in privacy and security, including recent legislation such as the GDPR. Prerequisite: ICT 4305.

**ICT 4351 .NET Programming with C# (4 Credits)**

Students will explore the fundamentals of C# and object-oriented programming by using Visual Studio to develop desktop and web applications, test and debug applications, perform object-relational mapping using Entity Framework, and connect with XML and SQL data sources. Students will identify and describe various .NET components, design issues, development solutions, and package managers, while gaining familiarity with the core .NET languages and CLR execution. Recommended prerequisite: ICT 4305.

**ICT 4361 Java Programming (4 Credits)**

This course enhances the student's experience in object-oriented design and software development by performing and discussing OO design for re-use of general purpose applications and small Java applications, including the Java Collection API and Swing user interface classes. Topics include the use of Java as an object-oriented programming language, including encapsulation, simple inheritance, and polymorphism; design of Java classes using Java interfaces and packages; implementation of design patterns in working Java code; and use of Java Base Classes. Students will gain experience in the use of a Java IDE. Note: This course does NOT address JavaScript. Prerequisite: ICT 4315.

**ICT 4370 Python Programming (4 Credits)**

This course starts with an introduction to Python programming covering basic programming concepts and Python syntax. It then continues to deepen students' knowledge of Python by teaching how to access data (text files, databases and other data storage technologies), and process and manipulate that data. Basics of creating front-end interfaces with Python are covered in order to allow students to produce more intuitive interaction with application users. Beyond core Python libraries, other commonly used Python libraries will also be utilized in the course. The course will focus on good programming practices and solving problems effectively. At the successful completion of the class, students will be able to create a number of different types of projects and execute them in Python, as well as continue learning and applying Python skills to data analytics, GIS and other areas of focus. Recommended prerequisite: ICT 4007 (if student has no prior programming experience).

**ICT 4400 Database Administration (4 Credits)**

This course introduces the roles and responsibilities, as well as the critical knowledge and skills, needed to function as a database administrator. The course focuses on Oracle and Microsoft SQL Server RDBMSs and the Oracle NoSQL databases. Database administration covers a range of topics which are covered in this course; installation, configuration, performance tuning, maintenance, and database security. Special focus will be paid to the architecture of the RDBMS and NoSQL systems, using it as the basis of much of the work throughout the course. There will be weekly hands-on lab work that afford students opportunities to gain valuable practical experience in managing databases. This course will function as an introduction to other courses in the Database Design and Administration concentration, which will give students the occasion to study these topics in greater depth. The course will conclude with an examination of the future of the database field, discussing quantum computing, cloud computing and block-chain technology.

**ICT 4405 Database Design and Implementation (4 Credits)**

This course concentrates on the relational database model and the conceptual, logical, and physical phases of database design and development. Entity-relationship modeling, data normalization, and Structured Query Language programming are core components of the class. The role and responsibilities of a database administrator are explored; and the concepts of database integrity and transaction management, concurrency protocols, and security schemes are examined. In addition, emerging data warehouse technologies are introduced. The course culminates in a project that allows students to demonstrate an understanding of all phases of the database life cycle (DBLC). Recommended prerequisite: ICT 4400.

**ICT 4410 Data Warehousing Design (4 Credits)**

Organizations with vision and courage are gaining competitive advantage by implementing data warehouses. Under the guidance of an executive sponsor, a team of data administrators, database specialists, and organizational analysts creates these contemporary decision support environments. Building a data warehouse is fundamentally different than building a subject area database for an operational system. In this course students use such data warehouse (DW) concepts as partitioning, granularity, record of source, and metadata as they learn how to build a viable decision support environment. Students further their understanding of such topics as architect development, data migration and integration, use of operational data stores, and transactional systems. Recommended prerequisite: ICT 4400.

**ICT 4415 Database Backup and Recovery with Lab (4 Credits)**

This course explores database backup and recovery strategies and tactics using both Oracle and SQL Server database systems. The course will include weekly lab work that will give students an opportunity to gain experience with Oracle and SQL Server databases. Topics include preparing backup, recovery and disaster plans, as well as performing complete and incomplete database recoveries using the Oracle Export/Import utility. Students also work with a SQL Server database, utilizing the SQL Server Management Studio. Students will be assigned a Linux Virtual environment that will be used for all Oracle administration, and they will install a SQL Server database locally that will be used for all SQL Server administration. Prerequisite: ICT 4400.

**ICT 4430 Database Security (4 Credits)**

Information Technology has become increasingly data-driven, requiring I.T. professionals to dramatically rethink how we protect corporate assets. This course strives to provide a perspective that intersects several technology disciplines: database administration, web-based application development, and technology management. Taking a defense-in-layers perspective, Database Security will provide students with an opportunity to gain an understanding of how data is protected from the perimeter to the data. Students will understand the nature of the types of threats and vulnerabilities to the web-based applications and underlying databases, and how to develop strategies to most effectively protect an enterprise's data.

**ICT 4451 Database Programming: Oracle PL/SQL (4 Credits)**

This course builds on ICT 4405 Database Design and Programming, allowing students to transform a database schema design into a database application prototype using Oracle's PL/SQL. Topics include advanced SQL DDL, DML, and scripting, PL/SQL constructs, stored procedures, modular design and development, software development processes, views, sequences, cursors, dynamic SQL, error handling, locking, as well as performance and tuning, and database security. Using virtual E-Labs, students design and develop a database and related PL/SQL applications. Recommended prerequisite: ICT 4405.

**ICT 4461 SQL Server with Lab (4 Credits)**

This course is an introduction to Microsoft SQL Server for both the DBA and Developer. The key new features of SQL Server are introduced and explored, and the various editions of SQL Server are contrasted. In-depth coverage is provided on how to use the new Microsoft SQL Server Management Studio for both administrative and development tasks. Special emphasis is given to query optimization techniques. An introduction to SQL Integration Services, SQL Analysis Services and SQL Reporting Services is also presented. Recommended prerequisite: ICT 4405.

**ICT 4462 Transact - SQL Programming (4 Credits)**

Transact-SQL is the primary programming interface between applications and the Microsoft SQL Server database. Transact-SQL can be sent from programs or applications to the SQL Server database or can be built into reusable database stored procedures. This course focuses on Transact-SQL in a stored procedure context. Topics include: basic and advanced SQL, SQL functions, stored procedure declaration and execution, cursors, temp tables, error handling, transaction management, security, and performance issues. The course uses a combination of lecture, textbook reading assignments, and hands-on lab assignments to meet its objectives. Recommended prerequisite: ICT 4405.

**ICT 4485 NoSQL Databases (4 Credits)**

Relational database systems have been dominant in the market for over forty years, and remain so today. However, the emergence of distributed and cloud computing, as well as the increasing need for storage of large datasets, have created the need for alternate data storage solutions. A number of different models / database management systems have been developed, that as a group are being referred to as NoSQL databases. A number of large, well-known companies use such databases. Some of the companies use more than one variety of NoSQL databases. This course will examine different non-relational (NoSQL) data models, those being Key-Value, Document, Column, Graph and the Object-Oriented database models. Students will learn about advantages and disadvantages of the different approaches. The class will include hands-on experience with a representative sample of NoSQL databases. Computing developments that spurred the existence of NoSQL databases, such as big data, distributed and cloud computing, will also be discussed. Recommended prerequisite: ICT 4405.

**ICT 4505 Website Design and Management (4 Credits)**

This course extends your web design and development skills and includes advanced HTML techniques and enhanced page design capabilities using CSS. The key to great web design is rooted in a solid foundation, which requires a plan or a "blueprint." We will explore best practices in information architecture (IA) and how to incorporate user-centered design (UCD) techniques as a standard practice in web design. Students will also develop an understanding and working knowledge of Cascading Style Sheets. Through the use of readings, examples, hands-on projects, and discussions, the class will build an understanding of the foundations and applications of user-centered design to plan, build, and manage a website. Through participation in a project and regular discussions, class members will experience working as active and contributing members of the class and knowledge-building community. Recommended prerequisite: ICT 4300.

**ICT 4510 Advanced Website Design and Management (4 Credits)**

Web development has become an integral part of the tech industry and has created a multitude of career options for job seekers. This course will enhance the knowledge gained in ICT-4505 by delving into HTML5 JavaScript APIs and Responsive design using a common CSS framework. Students will be introduced to beginner, intermediate and advanced JavaScript concepts. Finally, the foundational web languages HTML5, CSS and JavaScript will be used to build a fully functional client-side application. Prerequisite: ICT 4505.

**ICT 4515 Usability Design for Websites (4 Credits)**

This course expands on the basic knowledge of website design and development by providing an in-depth understanding of how to design a website with the user in mind. Students will gain knowledge about how the fields of human factors engineering and psychology (e.g., visual perception, attention, cognition, learning and memory, information processing) relate to the basis of usability design as well as how usability assessments are conducted. Usability guidelines for common functions such as web navigation, search, menus, scrolling, links, text, page layout, visual organization, etc. will be explored. Students will have the opportunity to develop a website that demonstrates appropriate use of important usability guidelines and conduct usability assessments with real users. Prerequisite: ICT 4505.

**ICT 4540 XML and Data in Application Development (4 Credits)**

XML is an open, text-based markup language that provides structural and semantic information to data. This 'data about data,' or metadata, provides meaning and context to the application using it, and supports manipulation and display. The course focuses on techniques to make this data useful for business applications, as well as for browser display. Hands-on experience with the XML formats and manipulation, which includes programming techniques, forms the weekly assignments, culminating in a summary project. Other standards, such as JSON, are discussed, as well as use of CSS for display of XML data. Some JavaScript is introduced to illustrate the document model and techniques for integration of data. Prerequisites: Students should have familiarity with constructing HTML web pages and data concepts. Familiarity with a data manipulation or programming language will be helpful.

**ICT 4555 Introduction to Animate CC (4 Credits)**

This course introduces students to rich media design, animation, and interactive development for the web, desktop, mobile, and more using Adobe Animate CC. Students learn the fundamentals of working in the Adobe Animate CC authoring environment to produce web assets, small animations, and basic interactive modules for multiple target platforms.

**ICT 4560 Web Graphics Production (4 Credits)**

This course introduces the fundamental concepts and techniques of digital graphics creation and image processing for both online publication and website interface design. Students learn the basics of correcting and modifying images, bitmap painting tools, vector drawing tools, typography, masking, web production techniques, and advanced image compositing. Integration of images and generated code into a website layout employing CSS is also covered.

**ICT 4561 Web Development with PHP (4 Credits)**

This course introduces students to programming Web applications using PHP and MySQL. Topics include processing form data, file uploads, object-oriented programming and database access. Students leverage a PHP framework and learn to install and configure a local development environment to test and develop their Web applications. Recommended prerequisite: ICT 4505.

**ICT 4570 Web Scripting with JavaScript (4 Credits)**

This course presents students with the principles necessary to design and develop client-side scripts used to build dynamic websites and applications. JavaScript concepts such as data types, control structures, functions and objects are discussed. Students learn how to write beginner and intermediate scripts. In addition, students are introduced to advanced JavaScript topics, including module development, distributed computing and security. Students are presented with real world examples of JavaScript and build an interactive and dynamic client-side application. Technologies covered in the course include JavaScript/ECMAScript, JQuery (a JavaScript library), JSON (a JavaScript-friendly data format), JavaScript as the J in AJAX, and JavaScript in HTML5 form interaction and validation. Recommended prerequisite: ICT 4505.

**ICT 4576 Native Application Development on Mobile Devices (4 Credits)**

During this course students learn how to use a set of languages and tools to build business and media-centric applications that run on mobile devices such as laptops, tablets, smartphones, and eReaders running on Windows, MAC OS, iOS, and Android. This course illustrates best practices for reusing code, structuring projects, and submitting applications to app stores. Throughout the course students utilize an IDE such as FDT or IntelliJ, MXML, and ActionScript to build cross-device native applications. Students also learn how to add functionality to their Adobe AIR native applications by leveraging third-party Native Extensions to access native features. Recommended prerequisite: ICT 4300.

**ICT 4580 Mobile Application Development with Web Standards (4 Credits)**

This course will enable students to take advantage of web standards (HTML5, CSS3, JavaScript) along with various popular frameworks and tools in the generation of both portable web applications for the browser and packaged applications for mobile devices. Students will examine the fundamentals behind good user and interaction design when targeting mobile devices and see what is appropriate for implementation on these platforms. Students will implement sample applications which may be deployed to the devices of your choice. Prerequisite: ICT 4570.

**ICT 4605 Principles of Information Security (4 Credits)**

This is a comprehensive Information Systems Security management course covering the eight basic principles of Information Assurance and Information Systems Security. The course follows the Common Body of Knowledge (CBK) convention established by the International Information System Security Certification Consortium, Inc. (ISC)<sup>2</sup>. This course serves as an introduction to the eight domains of information systems security with the emphasis on management issues. It provides the foundation of information systems security and the methodologies that organizations apply to analyze and achieve their security goals. Students learn about significant computer security laws and regulations, system security engineering, the development of effective security policies, system access controls, network security, encryption and security models. The course also covers specific security measures to include, but not limited to, physical security controls, network security, cloud security, telecommunications, and cryptography. Information covered includes contemporary issues of cybercrime, and business continuity and disaster recovery planning. The course applies a systems approach to security issues to analyze and develop security solutions. All topics are discussed in the context of a total enterprise-wide framework.

**ICT 4610 TCP/IP Networks (4 Credits)**

This course explores the operation of the TCP/IP protocol stack including its history, development, current applications, and future implications. The full range of TCP/IP protocols from IP and TCP to basic RPC issues and application protocols such as DNS, SMTP, FTP, SNMP and HTTP are studied. Students also study TCP/IP capabilities, alternatives, and performance issues. Security-specific protocols including SSL and IPSec are examined along with the security aspects of all other protocols. Mechanisms for Internet connectivity for homes and businesses are also covered. The course concludes with a survey of modern topics including Real-Time Communications and IPv6.

**ICT 4615 Identity and Access Management (4 Credits)**

Identity is the new security perimeter. Access can be determined based on a persona, a role, or a user type. Identity and Access Management (IAM), then, is the foundation for access to any secured computer resource and must be handled and managed carefully and deliberately. This course will provide students with the skills they'll need to succeed at designing and implementing access control mechanisms on networked systems. The course covers the principles and mechanisms that compose an overall IAM system and supports the National Institute of Standards and Technology (NIST) Special Publication 800-181, National Initiative for Cybersecurity Education (NICE) Cybersecurity Workforce Framework (otherwise known as the NICE Framework). Recommended prerequisite: ICT 4605.

**ICT 4670 Disaster Recovery and Business Continuity Planning (4 Credits)**

This course is an introduction to Disaster Recovery and Business Continuity (DR/BC) Planning. The course examines the steps required to identify mission-critical continuity needs of an organization, analyzes the legal & regulatory requirements for data security, and evaluates the various risks management approaches to identify and quantify business risk associated with business continuity. The course provides students the opportunity to create a Disaster Recover/Business Continuity (DR/BC) plan that incorporates business resumption planning, emergency response & communication, and data/system recovery techniques.

**ICT 4675 Healthcare Cybersecurity (4 Credits)**

This course will introduce students to information security risks facing the healthcare industry. Students will learn how to better protect healthcare organizations and their patients' data. Students will learn about recent security breaches, the impact of those breaches on healthcare organizations, and all of the key players involved. This course also covers the evolution of healthcare IT and the continuously evolving risk and regulatory landscape. Students will explore the regulations of HIPAA and how they relate to day-to-day operations in healthcare organizations. Additionally, this course will prepare students to support information security initiatives in order to protect the organization while furthering the advancement of healthcare IT capabilities. This is not a technical course, however we will be learning about how security is impacted by technology and what we must do across technology in order to secure our healthcare systems, our organizations, and our patients.

**ICT 4680 Principles of Cryptography (4 Credits)**

E-commerce has made cryptography a cornerstone of modern information systems security. Cryptology is a core component of all recognized information security certifications; however, it may be the least understood of the information security disciplines. This course focuses on the terminology and concepts needed to understand how cryptographic techniques are used to protect sensitive information. Topics include different types of ciphers (substitution, transposition, block and stream), Digital Signatures and Message Authentication Codes, public key infrastructure (PKI), secure sockets layer (SSL), and network protocols for encryption, among others. Lecture and reading materials are reinforced by hands-on experimentation in a virtual lab environment focused on real-world uses of cryptography. Internet resources are used to tie the course material to current technology trends. No programming experience or advanced mathematical skills are required for this course. Recommended prerequisite: ICT 4605.

**ICT 4685 Cloud and Internet Law (4 Credits)**

This course explores the legal and technical ramifications and implications created by cloud computing and Internet Law. This course also examines the types of issues and concerns that exist in the US and the world by the dynamic change in software, computer networking, and cloud infrastructure. This rapid change in computer networking, data, information, Internet, and cloud architecture directly impacts governments, companies, and individuals. Issues include how to handle data, information, security, privacy, civil and criminal laws, rules and regulations, contractual agreements, and service-level agreements between parties on many levels from service providers in different states, countries, and parts of the world. It is important that all of these issues are balanced by differing cultural standards and mores from all 50 States, all over our country and all around the world, including the legal (and sometimes not so legal) methods of protecting governments and companies in this ever-changing, "always-connected" world.

**ICT 4690 Computer Forensics with Lab (4 Credits)**

This course is concerned with providing an overview of the methods and tools utilized for collecting and preserving electronic digital evidence for the computer forensic process; the forensic examination, analysis, and report writing; and preparing for courtroom testimony about the forensic results. The course is supplemented by hands-on-exercises, case studies, and a moot court exercise in which each student will testify. Recommended prerequisites: ICT 4605, ICT 4610.

**ICT 4695 Application Security (4 Credits)**

In this course, students explore the security concepts, principles, and practices that are used to secure software applications throughout the modern software development lifecycle (SDLC). Topics include enhancing the agile/scrum development processes with secure design models and application risk analysis, application lifecycle management, defensive programming, secure DevOps, and AppSec issues with new technology and new consumer devices. Recommended prerequisite: ICT 4605.

**ICT 4701 Topics in Information and Communication Technology (4 Credits)**

This is an advanced special topics seminar course that may be offered to address a developing concept, an industry trend, or a new technology. The focus is on specialized areas of interest. Topics courses may be used as electives within the Information and Communications Technology degree and certificate programs, and, with advance approval from Academic Director, may substitute for core courses in the degree or certificate program.

**ICT 4800 Network Communications and the Internet (4 Credits)**

This course focuses on the fundamental concepts and technologies of communications networks and the Internet, including the information theory that is the foundation of modern communication systems. It emphasizes application of these concepts to the analysis and design of network solutions to meet various service provider and IT business requirements. Topics include network media, communications protocols and standards, LAN and WAN network architectures, the Public Switched Telephone Network, and current trends in networking via the Internet. Network components, such as modems, routers, switches, and voice communications systems are analyzed. The various transport media of copper, fiber, and wireless infrastructures are compared. Critical thinking is emphasized via discussions of current and future trends in network technology, global regulatory and political issues in voice/data/video communications, and Internet governance.

**ICT 4815 Managing Global Telecommunications Projects (4 Credits)**

Set in the context of today's convergence from the traditional telco/telephony world to next generation all-IP networks brought about by the Internet revolution, the course addresses managing across borders, cultures, time zones, and continents. In addition, the course explores managing conflicts of interest between carriers and over-the-top (OTT) players such as Apple, Google/Android and Skype. Related topics include the challenges and opportunities in vendor management between the old telco vendors of the West and their new competitors from the East. Finally, the course analyzes stakeholder management at the C- and SVP-level of the organization. A variety of assignments create opportunities for students to work in teams, and at other times to work individually on a set of real-world case studies derived from typical projects at leading global network operators and telecom vendors. This course applies project management best practices to the typical challenges faced by project managers in today's fast-paced, complex and highly competitive global telecom industry. Case studies are used to exemplify core project management challenges at an advanced level. Prerequisites: two courses in any of the following areas: Project Management, Technology Management, Telecommunications Technology.

**ICT 4830 Broadband Wireless Networks (4 Credits)**

This course examines the key broadband radio technologies at the center of today's rapid innovation in wireless networks. Wireless telecommunications networks are studied with an emphasis on the challenges and the approaches to deal with the immense wireless data traffic explosion from devices such as the iPhone, iPad, Android smartphones and connected laptops, as well as broadband services like VOIP and mobile video. The dominant wireless telecom technologies and protocols are presented, including 4G LTE, 5G, OFDM, MIMO, mobile IP, WIMAX, Wi-Fi and WPANs. The "triple play" convergence of voice, video, and data over wireless networks is analyzed. The wireless telecom industry is studied from standards, carrier, and technology perspectives, with an emphasis on radio networks as well as key application use cases.

**ICT 4835 Advanced Network Technologies (4 Credits)**

Technological advancements in networking within the last few years are revolutionizing concepts of networking for both Enterprises and Service Providers. This course demystifies these latest advancements in network technologies. Topics include in-depth coverage of modern networking elements, network requirements, Network Virtualization technologies, Software Defined Network (SDN), and Network Function Virtualization (NFV). Coverage of latest technology requirements includes elastic traffic, big data, mobility, QoS, QoE, and more. The course discusses SDN and NFV components, architecture, protocols, and use cases. Virtualization technologies include VLANs, OpenFlow, VPNs – IPSec and MPLS-based. The course emphasizes deep understanding, analyses, and evaluation of modern network architectures. Prerequisites: ICT 4800, ICT 4830.

**ICT 4840 Next Generation Wireless Networks and Services (4 Credits)**

The rapid innovation in wireless networks that is at the center of today's ICT industry takes place in the four areas of broadband radio, core & edge networks, wireless services, as well as devices and smart objects. This course focuses on the key next generation technologies at the core network, service and object layers. First, the role of the Internet Protocol Multimedia Subsystem (IMS) in the core network is examined, which is at the heart of many next generation deployments. At the service layer, this course explores wireless service architecture, including popular applications such as mobile real-time messaging, TV/video and mobile web services. The Internet of Things (IoT) plays an increasingly prominent role at the object layer of modern wireless network designs. A case study approach is taken to highlight core use cases from key industries including Smart Cities, the Smart Grid and Industry 4.0. Finally, wireless product development, deployment and operations are examined in the critical context of the conflict between over-the-top (OTT) and network operator based ecosystems. Prerequisite: ICT 4800.



**ICT 4845 Information Systems Security with Lab (4 Credits)**

In this course, students are introduced to security concepts that align with the Certified Information Systems Security Professional (CISSP) Common Body of Knowledge (CBK). They are instructed to be critical thinkers in their navigation through the network security landscape. Students focus on real-world examples of both perimeter network security and desktop security, which can be used in any environment, simple or complex. Students have the opportunity to work with a range of network security toolboxes in a hands-on software lab environment. Recommended prerequisites: ICT 4800, ICT 4605.

**ICT 4901 Capstone Project (4 Credits)**

The Capstone Project provides students the opportunity to research a topic, problem, or issue within their field of study, and work individually with a Capstone advisor. Similar in weight to a thesis, but more flexible, this final project will synthesize and apply core concepts acquired from the program. The student will select an appropriate Capstone advisor who is knowledgeable in the field of study to work closely with and who can guide the research project. Evaluation will be focused on the quality and professionalism of applied research and writing; critical and creative thinking; problem-solving skills; knowledge of research design, method, and implementation; and contribution to the field and topic of study. Please see the Capstone Guidelines for additional details. Prerequisites: A Capstone Proposal that has been approved by both the Capstone Advisor and the Academic Director, acceptance as a degree candidate, completion of at least 40 quarter-hours (including all core courses) with a cumulative GPA of 3.0 or better. A final grade of a B- or better is required to pass.

**ICT 4902 Capstone Seminar (4 Credits)**

The Capstone Seminar is a graduate seminar in which students utilize the knowledge and skills gained through the degree program to create a culminating work that critically addresses a problem in their degree field of study. The students produce a Capstone of 7000-8000 words that presents a position on a relevant problem, supports the position with professional and academic literature, analyzes and tests the proposed solution, and discusses the findings as related to the field of study. The seminar is dependent upon quality, collegial discussion, and feedback of students' research and work products, under the facilitation of a faculty member. The course structure guides the students through the process of independent, secondary research and writing of a Capstone. No primary research is allowed. Students generate the course content through ongoing discussion and peer feedback on the Capstone process and individual topic areas under investigation. Students professionally and academically communicate through written work and oral presentation. Students must have: Acceptance as a degree candidate, completion of at least 40 quarter-hours (including all core courses) with a cumulative GPA of 3.0 or better. A final grade of B- or better is required in this course to meet degree requirements. Students must complete the Capstone Seminar in one quarter; no incomplete grades are assigned.

**ICT 4980 Internship (1-4 Credits)**

The ICT internship is designed to offer students a practical educational experience in an industry related setting. The internship is an individualized learning experience that is directly related to the knowledge and skills covered in the ICT master's degree program. Students are responsible for finding their own internship site and proposing their internship ideas. University College will send notification to all ICT students if they hear of internship possibilities. Students may also work through the DU career center to explore opportunities for internship experiences. The objectives, activities, responsibilities, and deliverables for the internship are defined in a training plan that is developed by the student jointly with the internship supervisor at the sponsoring organization. The training plan is approved by the academic director. Prerequisites: The student must be unconditionally accepted in the ICT degree program, have completed a minimum of 28 hours of graduate coursework, including at least two core courses, and have earned a GPA of 3.0 or better. Enrollment must be approved by the academic director.

**ICT 4991 Independent Study (1-4 Credits)**

This is an advanced course for students wishing to pursue an independent course of study. The student must be accepted in a degree program, have earned a grade point average of 3.0 or better, obtained the approval of the department director, and have completed the Independent Study form and filed the form with all appropriate offices before registering for the independent study. Independent Study is offered only on a for-credit basis.

**ICT 4992 Directed Study (1-4 Credits)**

This is an advanced course for students wishing to pursue a directed course of study. The student must be accepted in a degree program, have earned a grade point average of 3.0 or better, obtained the approval of the department director, and have completed the Directed Study form and filed the form with all appropriate offices before registering for the directed study. Directed Study is offered only on a for-credit basis.