INFORMATION AND COMMUNICATIONS TECHNOLOGY

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Master of Science in Information and Communications Technology with a concentration in Database Design and Administration

The Database Design and Administration master's degree concentration is offered online or on campus at the University of Denver in the evenings, or in a combination of both, to meet the needs of busy adults who are current or aspiring database designers and administrators. Students will learn how to design, administer, fine-tune, and maintain databases with a database administration degree, plus develop business acumen that will help them excel in the Information and Communications Technology (ICT) field. Master's degree students learn from expert instructors who work in the fields in which they teach, providing cutting-edge insight to what is needed to work efficiently and effectively in this sector of ICT.

The combination of required and elective courses in the master's degree program covers key database system (DBS) technologies such as SQL Server, Oracle PL/SQL, Transact-SQL programming, and NoSQL databases. This comprehensive content delivered in a hands-on manner provides both the knowledge and the specific skills needed to put the student on the path to earn key industry certifications for vendor database platforms.

This degree prepares students to do the following:

- Analyze, design, develop, test, deploy, administer and maintain database applications and database security based on industry best practices and end-user requirements
- Apply data modeling, data warehousing, performance tuning, programming and maintenance through technologies such as SQL Server, Oracle, PL/SQL Transact-SQL, and NoSQL
- Create plans to solve organizational issues using business management strategies directly related to database administration theories and applications
- Formulate plans for database installation and configuration, maintenance, and backup and recovery

Master of Science in Information and Communications Technology with a concentration in Geographic Information Systems

The Geographic Information Systems (GIS) master's degree concentration is offered online or on campus at the University of Denver in the evenings, or in a combination of both, to meet the needs of busy adults. GIS training prepares students to apply geographic information systems technology to solve real-world problems, whether determining the best location for a new store, analyzing environmental damage, or detecting crime patterns in a city. GIS solutions provide the capability to store, retrieve, and analyze spatial information by combining layers of data to yield valuable understanding of a locale.

As a current or aspiring GIS professional, you will receive applied instruction from professional practitioners who work in the fields in which they teach as you learn to plan, implement, and execute a GIS project through remote sensing, internet mapping, or digital image processing. Also, you will develop a valuable business background with creative, solution-oriented techniques through this versatile program, which emphasizes applied education that will propel your GIS career forward. Students will explore GIS fundamentals at a very hands-on, practical level necessary to succeed in the field of GIS. Customize your Information and Communications Technology master's degree through the innovative Professional Options Curriculum using our convenient online degree builder tool, which allows you to select courses that cater to your specific career needs.

This degree prepares students to do the following:

- Analyze the nature of, uses for, and implementation processes for geographic data
- Select appropriate applications of GIS technology to solve spatial problems based on organizational/client needs
- Analyze real-world problems and select the appropriate GIS tools and processes to address the issues
- Plan, implement, and execute a GIS project

Master of Science in Information and Communications Technology with a concentration in Information Systems Security

The Information Systems Security master's degree concentration is offered online or on campus at the University of Denver in the evenings, or in a combination of both, to meet the needs of busy adults. A master's degree concentration in Information Systems Security from University College—a designated National Center of Academic Excellence in Cyber Defense Education—combines technology, management, and business skills to prepare graduates for an exciting, high-demand career in Information and Communications Technology (ICT) security.

Master's degree students receive applied instruction as they learn to navigate real-world security challenges, such as setting up a secure network, securing servers, and problem solving hypothetical security situations. Students also garner career-relevant knowledge on related ICT subjects to better relate the challenges of the rapidly evolving world of cyber security and cyber threats to other key trends in the ICT industry. To ensure up-to-the-minute knowledge and skills, the curriculum was designed around the Common Body of Knowledge for CISSP certification developed by the International Information Systems Security Certifications Consortium (ISC)². In addition, the program was developed in collaboration with the Colorado Springs and Denver chapters of the Information Security Systems Association (ISSA), and the courses have been mapped to the Committee on National Security Systems (CNSS) standards. The University of Denver has been designated by NSA/DHS as a National Center of Academic Excellence in Cyber Defense Education.

This degree prepares students to do the following:

- Develop and implement information security policies and procedures to meet organizational needs based on best practices
- Analyze security scenarios and design secure network solutions and applications
- Create strategies to establish secure operations, access control methods, and system security to meet organizational/client requirements
- Plan for business continuity based on organizational culture and requirements
- Evaluate encryption standards and solutions
- Conduct computer forensics analysis

Master of Science in Information and Communications Technology with a concentration in Mobile Application Development

The Mobile Application Development master's degree concentration is offered online or on campus at the University of Denver in the evenings, or in a combination of both, to meet the needs of busy adults. With mobile application development on the rise, current software and web developers need to update their mobile app design skills to meet the growing demand in the marketplace. In this master's degree program, students will learn best practices in browser-based and packaged apps, 3rd-party native extensions, distribution to app stores, and cross-platform application development. Degree-seekers will acquire specialized developer knowledge and the technical skillset needed to succeed as professional mobile app designers and developers.

With a wide range of electives to choose from, students can expand their technical skills in JavaScript, learn about next-gen wireless networks, learn PHP, or brush up on their knowledge of Flash. In the rapidly evolving, converged world of ICT, it is vital to grasp the diverse industry fundamentals, while also gaining an insider's perspective regarding specific areas of ICT such as mobile application design and development. The master's degree in Mobile Application Development provides a high level of applied knowledge pertaining to mobile app design and development that will help launch a career as a mobile app developer, or elevate students to new current positions.

This degree prepares students to do the following:

- Analyze and apply best practices in browser-based and packaged apps, 3rd-party native extensions, distribution to app stores, and cross-platform application development
- Compare, contrast, and use IDEs such as FDT or IntelliJ IDEA and SDKs such as Apache Flex
- Critique and build mobile applications in programming languages such as MXML, ActionScript, and Java
- Design and develop mobile applications applying best practices in code reuse, mobile usability, and mobile web standards such as HTML5, CSS3, and JavaScript
- Integrate XML for data description and exchange

Master of Science in Information and Communications Technology with a concentration in Project Management

The Project Management master's degree specialty through the Information and Communications Technology (ICT) program is offered online or on campus at the University of Denver in the evenings, or in a combination of both, to meet the needs of busy adults. Students will combine information and communication technology skills with a project management and business background and become a proficient leader within the IT field. Students will receive hands-on, practical instruction from professional practitioners, who work in the fields in which they teach, on the tools and techniques of effective project management. Students will learn how to develop a clear plan that places a project in the context of an organization's strategic plan, while considering the implications information and communication technologies present in any given project.

Graduates of the Project Management program will gain a firm grasp on converging information and communication technologies and learn to understand the fundamentals of each sector. Recognizing how each ICT subject connects to one another, from information security systems to geographic information systems, will give students the competitive edge needed in this dynamic industry. The content for this concentration has been developed to parallel the Project Management Institute's (PMI)® *A Guide to the Project Management Body of Knowledge, (PMBOK® Guide) – Fifth Edition (with Sixth Edition updates), Project Management Institute, Inc., 2013.* The unique curriculum prepares students to succeed on the PMI® Project Management Professional (PMP)® Certification Exam.

This degree prepares students to do the following:

- Summarize and apply the basic principles of project management and become proficient in the use of project management software
- Analyze and apply agile concepts and techniques
- Design a comprehensive risk management plan for a project
- Create strategies to manage the complexity inherent in large-scale projects
- Relate project scope to cost, time, and resource requirements
- Develop procurement plans and assess project contracts

Master of Science in Information and Communications Technology with a concentration in Software Design and Programming

The Software Design and Programming master's degree concentration is offered online or on campus at the University of Denver in the evenings, or in a combination of both, to meet the needs of busy adults. Students will expand their knowledge of software design and programming principles, while developing the in-depth skills needed to succeed in the field with a Software Design and Programming master's degree. Current or aspiring programmers will practice Object Oriented methods and programming, with a focus on modern web-based, client-server applications and systems. Students are able to select from a variety of elective courses that best meet their specific Information and Communications Technology (ICT) career goals.

Degree-seekers learn how to develop quality software programs and applications, apply Software Quality Assurance practices, use software management processes such as the Unified Software Development Process, and code in languages such as C#, Java, Python, and PHP. Skills are applied in hands-on assignments, with expert instructors guiding software degree students to identify and overcome the challenges presented by designing and programming software with various languages and development tools.

This degree prepares students to do the following:

- Design software using best practices in security, Software Quality Assurance, and the Unified Software Development Process
- Generate program code in languages such as C#, Java, Python, and PHP
- Create database programming and queries
- Analyze the concepts of object oriented methods and programming and create code using the methodology
- Compare and contrast the features and benefits of IDEs such as Eclipse, NetBeans, and Visual Studio
- Assess appropriate implementations of frameworks such as J2EE, .NET, and Ruby on Rails

Master of Science in Information and Communications Technology with a concentration in Technology Management

The Technology Management master's degree concentration is offered online or on campus at the University of Denver in the evenings, or in a combination of both, to meet the needs of busy adults. The Technology Management degree concentration represents the convergence of business and technology and emphasizes the impact technology can have on strategic and operational objectives when applied through sound business management practices. With the right technical skills, combined with a strategic perspective regarding critical business needs, students will be prepared to meet current industry demands, and positioned to meet the demands of tomorrow.

Graduates with a Technology Management master's degree concentration or graduate certificate become proficient in creating, managing, and using technology to accomplish strategic organizational goals as they expand and strengthen their knowledge and skills in creative thinking, strategic and tactical decision making, and global awareness. In addition to the practical education received online or on campus, Technology Management master's degree students will also receive a broader understanding of how related IT sectors impact their technology management roles.

This degree prepares students to do the following:

- Formulate plans to manage technologies for strategic advantage
- Develop and evaluate business cases based on organizational and client requirements
- Assess the role of strategic alliances within an organization
- Summarize project management principles and processes in relation to technology management strategies
- Create and defend IT service assurance plans
- Analyze cloud and internet law across various IT scenarios
- Evaluate strategies and utilize best practices in technology forecasting and innovation

Master of Science in Information and Communications Technology with a concentration in Telecommunications Technology

The Telecommunications Technology master's degree concentration is offered online to meet the needs of busy adults. this degree prepares students to become proficient, technical leaders within the Information and Communications Technology (ICT). Students will learn how to evaluate emerging telecommunications technologies, wireless networks and services, and the convergence of voice, data, and multimedia services on the global IP network.

Students will learn how to assess and analyze telecommunications technologies, plus gain vital skills necessary to design, develop, and implement telecommunications systems such as wireless networks. The program emphasizes the challenges and approaches to deal with the immense wireless data traffic explosion from devices such as the iPhone, iPad, Android smartphones, connected laptops and the Internet of Things (IoT), as well as broadband services like VOIP and mobile video.

This degree prepares students to do the following:

- Analyze and design network solutions
- Analyze the "triple play" convergence of voice, video, and data over wireless networks
- Evaluate and apply best practices in network security
- Create plans to manage global telecommunications projects
- Evaluate next generation wireless networks and services

Master of Science in Information and Communications Technology with a concentration in Web Design and Development

The Web Design and Development master's degree concentration is offered online or on campus at the University of Denver in the evenings, or in a combination of both, to meet the needs of busy adults. The program provides an in-depth knowledge of web design and web development through hands-on instruction. Students will move beyond the development of first-generation HTML-based Web pages and learn to create interactive, state-of-the-art, Web-based applications that support the demands of contemporary e-business processes by pursuing a web design degree. Students will use a variety of essential software tools employed in professional web development projects, such as Animate CC, AJAX, and Ruby on Rails. The real-world development scenarios, coupled with the hands-on learning experience provided by professional practitioners who work in the fields in which they teach, result in a highly career-relevant, innovative degree in web design and development.

In addition to IT fundamentals, students will also develop essential business and problem-solving skills that will help them thrive in any organization.

In an increasingly technological world, it is vital to understand the fundamentals of other areas of the Information and Communications Technology (ICT) field, and how each converges with web design and web development.

This degree prepares students to do the following:

- Create interactive web-based applications for e-business processes and consumer demands using tools such as cascading style sheets, web graphics construction, interface design and usability, web scripting, and databases
- Create requirements for and design the user experience by applying UX principles such as user personas, information design, wireframing, and prototyping
- Analyze enterprise goals and apply information architecture and web-design foundational principles and theories to create client-server and cloud-based solutions
- Compare and contrast potential solutions for web, app, and mobile scenarios and apply technology such as JavaScript, HTML5, CSS3, XML, PHP, Python, and Ruby on Rails
- Assess how web design and development converges within the context of security, software, database design, and telecommunications

Certificate in Information and Communications Technology with a concentration in Database Design and Administration

The graduate certificate in Database Design and Administration is offered online or on campus at the University of Denver in the evenings, or in a combination of both, to meet the needs of busy adults who are current or aspiring database designers and administrators. Certificate students will expand their skillsets to include designing, administering, fine-tuning, and maintaining databases with a graduate certificate in database design and administration concentration. Expert instructors who work in the fields in which they teach provide excellent insight to what is needed to work efficiently and effectively in this sector of IT.

This certificate prepares students to become leaders in database design, development, and administration while expanding their skillsets to include data modeling, data warehousing, performance tuning, programming, and building and maintaining client-server databases. The combination of required and elective courses in the graduate certificate program covers key database system (DBS) technologies such as SQL Server, Oracle PL/

SQL, Transact-SQL programming, and NoSQL databases. This extensive content delivered in a hands–on manner provides both the knowledge and the specific skills needed to put the student on the path to earn key industry certifications for vendor database platforms. Credits earned through this graduate certificate may apply toward a master's degree in Information and Communications Technology.

Certificate in Information and Communications Technology with a concentration in Information Systems Security

The graduate certificate Information Systems Security offered online or on campus at the University of Denver in the evenings, or in a combination of both, to meet the needs of busy adults. A graduate certificate in Information Systems Security from University College—a designated National Center of Academic Excellence in Cyber Defense Education—combines technology, management, and business skills to prepare graduates for an exciting, high–demand career in IT security.

Certificate classes at University College use innovative lab experiences to provide hands–on expertise with industry–current security tools. Students also garner career–relevant knowledge on related IT subjects to better relate the challenges of the rapidly evolving world of cyber security and cyber threats to other key trends in the ICT industry. To ensure up-to-the-minute knowledge and skills, the curriculum was designed around the Common Body of Knowledge for CISSP certification developed by the International Information Systems Security Certifications Consortium (ISC)². In addition, the program was developed in collaboration with the Colorado Springs and Denver chapters of the Information Security Systems Association (ISSA), and the courses have been mapped to the Committee on National Security Systems (CNSS) standards. The University of Denver has been designated by NSA/DHS as a National Center of Academic Excellence in Cyber Defense Education. Credits earned through this graduate certificate may apply toward a master's degree in Information and Communications Technology.

Certificate in Information and Communications Technology with a concentration in Mobile Application Development

The graduate certificate in Mobile Application Development is offered online or on campus at the University of Denver in the evenings, or in a combination of both, to meet the needs of busy adults. Current software and web developers need to update their mobile app design skills to meet the growing demand in the marketplace, and a graduate certificate will help expand skills and provide credentials needed to be competitive in the field. Students in the mobile application concentration will learn best practices in browser–based and packaged apps, 3rd-party native extensions, distribution to app stores, and cross–platform application development. Certificate students will also acquire specialized developer knowledge and the technical skillset needed to succeed as professional mobile app designers and developers.

Certificate students will be able to expand their technical skills in JavaScript, learn about next gen wireless networks, learn PHP, or brush up on knowledge of other mobile application development tools. Students at University College gain a strategic business perspective and problem–solving skills that will help them thrive in any organization. In the rapidly evolving, converged world of ICT, it is vital to grasp the diverse industry fundamentals, while also gaining an insider's perspective regarding specific areas of ICT such as mobile application design and development. Credits earned through this graduate certificate may apply toward a master's degree in Information and Communications Technology.

Certificate in Information and Communications Technology with a concentration in Project Management

The graduate certificate in Project Management through the Information and Communications Technology program is offered online or on campus at the University of Denver in the evenings, or in a combination of both, to meet the needs of busy adults. Certificate students will learn to combine information and communication technology skills with a project management and business background and become a proficient leader within the Information and Communications Technology (ICT) field. Students will receive hands–on, practical instruction from professional practitioners who work in the fields in which they teach on the tools and techniques of effective project management. Additionally, students will learn how to develop a clear plan that places a project in the context of an organization's strategic plan, while considering the implications information and communication technologies present in any given project.

Project Management concentration students will learn about converging information and communication technologies and the fundamentals of each sector. Recognizing how each ICT subject connects to one another, from information security systems to geographic information systems, will give students the competitive edge needed in this dynamic industry. The content for this graduate certificate has been developed to parallel the Project Management Institute's (PMI)® *A Guide to the Project Management Body of Knowledge, (PMBOK® Guide) – Fifth Edition (with Sixth Edition updates), Project Management Institute, Inc., 2013.* The unique curriculum prepares students to succeed on the PMI® Project Management Professional (PMP)® Certification Exam. Credits earned through this graduate certificate may apply toward a master's degree in the Information and Communications Technology program.

Certificate in Information and Communications Technology with a concentration in Software Design and Programming

The graduate certificate in Software Design and Programming is offered online or on campus at the University of Denver in the evenings, or in a combination of both, to meet the needs of busy adults. Certificate students will be able to expand their skillsets to include software design and programming principles, while developing the in–depth knowledge needed to succeed in the field with a Software Design and Programming

certificate. Current or aspiring programmers will practice Object Oriented methods and programming, with a focus on modern web-based, client-server applications and systems.

Certificate students learn how to develop quality software programs and applications, apply Software Quality Assurance practices, use software management processes such as the Unified Software Development Process, and code in languages such as C#, Java, Python, and PHP. Expert instructors guide software certificate students to identify and overcome the challenges presented by designing and programming software with various languages and development tools. A comprehensive perspective is also provided at University College, conveying how other technology domains such as application security and database design, affect software programming. Credits earned through this graduate certificate may apply toward a master's degree in the Information and Communications Technology program.

Certificate in Information and Communications Technology with a concentration in Technology Management

The graduate certificate in Technology Management is offered online or on campus at the University of Denver in the evenings, or in a combination of both, to meet the needs of busy adults. Certificate students will learn how the convergence of business and technology impacts the strategic and operational objectives. Students will gain the right technical skills, combined with a strategic perspective regarding critical business needs, as they are prepared to meet current industry demands, and positioned to meet the demands of tomorrow.

The Technology Management concentration allows students to become proficient in creating, managing, and using technology to accomplish strategic organizational goals as they expand and strengthen their knowledge and skills in creative thinking, strategic and tactical decision making, and global awareness. This applied Technology Management certificate offers professionals an opportunity to receive applied instruction from professional practitioners who bring deep expertise in business management strategies and their technological implications. Credits earned through this graduate certificate may apply toward a master's degree in the Information and Communications Technology program.

Certificate in Information and Communications Technology with a concentration in Telecommunications Technology

The graduate certificate in Telecommunications Technology is offered online to meet the needs of busy adults. The Telecommunications Technology concentration provides practical telecommunications instruction, including evaluating emerging telecommunications technologies, wireless networks and services, and the convergence of voice, data, and multimedia services on the global IP network. Certificate students will learn how to assess and analyze telecommunications technologies, plus gain vital skills necessary to design, develop, and implement telecommunications systems such as wireless networks. The dominant wireless telecom technologies and protocols are presented, including OFDM, MIMO, mobile IP, WIMAX, LTE, and WPANs.

In addition to ICT fundamentals, students will also develop essential strategic business and problem-solving skills that will help them thrive in any organization by creating effective alliances throughout the technology sector. Credits earned through this graduate certificate may apply toward a master's degree in the Information and Communications Technology program.

Certificate in Information and Communications Technology with a concentration in Web Design and Development

The Web Design and Development graduate certificate is offered online or on campus at the University of Denver in the evenings, or in a combination of both, to meet the needs of busy adults. Certificate students will move beyond developing first-generation HTML-based Web pages and learn to create interactive, state-of-the-art, Web-based applications that support the demands of contemporary e-business processes. The certificate program provides an in-depth knowledge of web design and web development through hands-on instruction. Students will gain the competitive advantage needed to meet current industry demands, as well as the foundations to meet the demands of tomorrow by expanding their IT skillset with a certificate.

Students will use a variety of essential software tools employed in professional web development projects, such as Animate CC, AJAX, and Ruby on Rails. The real-world development scenarios, coupled with the hands-on learning experience provided by professional practitioners who work in the fields in which they teach, result in a highly career-relevant, innovative graduate certificate in web design and development. Web design and development will be put in the context of subjects such as information systems security, software and database design, and telecommunications, and students will learn how their work is impacted by these different sectors. Credits earned through this graduate certificate may apply toward a master's degree in the Information and Communications Technology program.

Master's Degree Admission
Application Deadlines
- Fall 2018 Final Submission Deadline: July 20, 2018
- Fall 2018 Deadline for Applicants Educated Outside the U.S.: June 15, 2018
- Winter 2019 Final Submission Deadline: October 26, 2018
- Winter 2019 Deadline for Applicants Educated Outside the U.S.: September 28, 2018

- Spring 2019 Final Submission Deadline: February 8, 2019
- Spring 2019 Deadline for Applicants Educated Outside the U.S.: January 11, 2019
- Summer 2019 Final Submission Deadline: April 26, 2019
- Summer 2019 Deadline for Applicants Educated Outside the U.S.: March 29, 2019

Admission Requirements

- **Online admission application**
- **$75.00 Application Fee**
- **University Minimum Degree and GPA Requirements**
- **Transcripts:** (http://bulletin.du.edu/graduate/admission-and-enrollment-policies/admission-process-and-standards-for-all-applicants/transcripts-and-proof-of-degree) One official transcript from each post-secondary institution.
- **Letters of Recommendation**: Two (2) letters of recommendation are required. Letters should be submitted by recommenders through the online application.
- **Personal Statement**: A personal statement (two pages double spaced, 450-550 words) is required. The statement should include information on how the degree will enhance career plans and meet educational goals. Some questions to consider are (a) what do you expect to learn and achieve in your degree program? (b) what kind of professional position do you anticipate having five years after you earn this degree? (c) what experiences have you had that form the foundation for these career or educational goals? Sharing personal experiences, abilities, achievements, and goals is encouraged. This document has considerable influence in the decision to admit applicants with attention given to written communication skills, clarity, and organization.
- **Résumé**: The résumé (or C.V.) should include work experience, research, and/or volunteer work.

Additional Standards for Non-Native English Speakers

Official scores from the Test of English as a Foreign Language (TOEFL), International English Language Testing System (IELTS) or Cambridge English: Advanced (CAE) are required of all graduate applicants, regardless of citizenship status, whose native language is not English or who have been educated in countries where English is not the native language. The minimum TOEFL/IELTS/CAE test score requirements for the degree program are:

- **Minimum TOEFL Score (paper-based test):** 550
- **Minimum TOEFL Score (internet-based test):** 80 with minimum of 20 on each subscore
- **Minimum IELTS Score:** 6.5 with minimum of 6.0 on each band score
- **Minimum CAE Score:** 176 with minimum of 169 on each band score
- **English Conditional Admission Offered:** Master's degree applicants who do not meet the required level of English proficiency may be considered for conditional acceptance if all other admission criteria are met. Prior to enrolling in any graduate-level coursework, English Conditional Acceptance (ECA) requires an evaluation by the University of Denver's English Language Center (ELC) and successful completion of intensive ELC English courses including the Graduate Preparation Program. Academic classes may not be taken while students are enrolled at the English Language Center. As an alternative to the English Language Center, an applicant may become fully admitted by submitting sufficient TOEFL/Academic IELTS/CAE scores.

Read the English Language Proficiency (http://bulletin.du.edu/graduate/admission-and-enrollment-policies/additional-standards-for-non-native-english-speakers/english-language-proficiency-ielts-toefl) policy for more details.

Read the English Conditional Admission (ECA) (http://bulletin.du.edu/graduate/admission-and-enrollment-policies/additional-standards-for-non-native-english-speakers/english-conditional-admission-eca)policy for more details.

Read the Required Tests for GTA Eligibility (http://bulletin.du.edu/graduate/admission-and-enrollment-policies/additional-standards-for-non-native-english-speakers/required-tests-for-gta-eligbility) policy for more details.

Additional Standards for International Applicants

Per Student & Exchange Visitor Program (SEVP) regulation, international applicants must meet all standards for admission before an I-20 or DS-2019 is issued, [per U.S. Federal Register: 8 CFR § 214.3(k)] or is academically eligible for admission and is admitted [per 22 C.F.R. §62]. Read the Additional Standards For International Applicants (http://bulletin.du.edu/graduate/admission-and-enrollment-policies/additional-standards-for-international-applicants) policy for more details.

Financial Aid

There are many different options available to finance your education. Most University of Denver graduate students are granted some type of financial support. Our Office of Financial Aid is committed to helping you explore your options.

Certificate Admission

Application Deadlines

- Fall 2018 Final Submission Deadline: July 20, 2018
- Fall 2018 Deadline for Applicants Educated Outside the U.S.: June 15, 2018
- Winter 2019 Final Submission Deadline: October 26, 2018
- Winter 2019 Deadline for Applicants Educated Outside the U.S.: September 28, 2018
- Spring 2019 Final Submission Deadline: February 8, 2019
- Spring 2019 Deadline for Applicants Educated Outside the U.S.: January 11, 2019
- Summer 2019 Final Submission Deadline: April 26, 2019
- Summer 2019 Deadline for Applicants Educated Outside the U.S.: March 29, 2019

Admission Requirements

- **Online Admission Application**
- **$50.00 Application Fee**
- **University Minimum Degree and GPA Requirements**
- **Transcripts:** (http://bulletin.du.edu/graduate/admission-and-enrollment-policies/admission-process-and-standards-for-all-applicants/transcripts-and-proof-of-degree) One official transcript from each post-secondary institution.
- **Résumé**: The résumé (or C.V.) should include work experience, research, and/or volunteer work.

Admission Standards for Non-Native English Speakers

Official scores from the Test of English as a Foreign Language (TOEFL), International English Language Testing System (IELTS) or Cambridge English: Advanced (CAE) are required of all graduate applicants, regardless of citizenship status, whose native language is not English or who have been educated in countries where English is not the native language. The minimum TOEFL/IELTS/CAE test score requirements for the degree program are:

- **Minimum TOEFL Score (paper-based test):** 550
- **Minimum TOEFL Score (internet-based test):** 80 with minimum of 20 on each subscore
- **Minimum IELTS Score:** 6.5 with minimum of 6.0 on each band score
- **Minimum CAE Score:** 176 with minimum of 169 on each band score
- **English Conditional Admission Offered:** No, University College certificate programs do not offer English Conditional Admission.

Read the English Language Proficiency (http://bulletin.du.edu/graduate/admission-and-enrollment-policies/additional-standards-for-non-native-english-speakers/english-language-proficiency-ielts-toefl) policy for more details.

Read the English Conditional Admission (ECA) (http://bulletin.du.edu/graduate/admission-and-enrollment-policies/additional-standards-for-non-native-english-speakers/english-conditional-admission-eca)policy for more details.

Read the Required Tests for GTA Eligibility (http://bulletin.du.edu/graduate/admission-and-enrollment-policies/additional-standards-for-non-native-english-speakers/required-tests-for-gta-eligbility) policy for more details.

Additional Standards for International Applicants

Per Student & Exchange Visitor Program (SEVP) regulation, international applicants must meet all standards for admission before an I-20 or DS-2019 is issued, [per U.S. Federal Register: 8 CFR § 214.3(k)] or is academically eligible for admission and is admitted [per 22 C.F.R. §62]. Read the Additional Standards For International Applicants (http://bulletin.du.edu/graduate/admission-and-enrollment-policies/additional-standards-for-international-applicants) policy for more details.

Financial Aid

There are many different options available to finance your education. Most University of Denver graduate students are granted some type of financial support. Our Office of Financial Aid is committed to helping you explore your options.

Master of Science in Information and Communications Technology with a Concentration in Database Design and Administration

Degree Requirements

Code	Title	Credits
Core course requirements		
ICT 4000	ICT Business Foundations	4
ICT 4005	ICT Technical Foundations	4

ICT 4010	Enterprise Architecture	4
ICT 4901	Capstone Project	4
or ICT 4902	Capstone Seminar	
or ICT 4904		
Concentration requirements		
ICT 4300	Web Enabled Information Systems	4
ICT 4400	Database Administration	4
ICT 4405	Database Design and Implementation	4
ICT 4410	Data Warehousing Design	4
Elective requirements (Choose four courses):		16
ICT 4100	Principles of Project Management	
ICT 4305	Object-Oriented Methods	
ICT 4415	Database Backup and Recovery with Lab	
ICT 4451	Database Programming: Oracle PL/SQL	
ICT 4461	SQL Server with Lab	
ICT 4462	Transact - SQL Programming	
ICT 4485	NoSQL Databases	
ICT 4505	Website Design and Management	
ICT 4540	XML and Data in Application Development	
ICT 4605	Principles of Information Security	
ICT 4680	Principles of Cryptography	
ICT 4695	Application Security	
Total Credits		48

Minimum number of credits required: 48

Students may choose from the elective options above, or they may work with their advisor to choose electives.

A satisfactory quality of achievement with a grade point average of "B" (3.0) or better is required in graduate coursework accepted for the degree. The average is determined on the basis of the University's grading system. In no case, may more than one-fourth of the hours accepted toward the degree be of "C" grade. A grade lower than "C" renders the credit unacceptable for meeting degree requirements. Students must earn a grade of B- or better in the Capstone Project or Capstone Seminar.

Master of Science in Information and Communications Technology with a Concentration in Geographic Information Systems

Degree Requirements

Code	Title	Credits
Core coursework requirements		
ICT 4000	ICT Business Foundations	4
ICT 4005	ICT Technical Foundations	4
ICT 4010	Enterprise Architecture	4
ICT 4901	Capstone Project	4
or ICT 4902	Capstone Seminar	
or ICT 4904		
Concentration requirements		
GIS 4101	Introduction to Geographic Information Systems	4
GIS 4700	Remote Sensing I	4
Select three of the following:		12
GIS 4520	GIS in Telecommunications	
GIS 4620	Geodatabase Application	
GIS 4690	GPS for GIS	
GIS 4740	Remote Sensing II	
GIS 4860	Internet Mapping	
Elective requirements (Choose three courses):		12

GIS 4080	Python Programming in GIS	
GIS 4520	GIS in Telecommunications	
GIS 4620	Geodatabase Application	
GIS 4690	GPS for GIS	
GIS 4740	Remote Sensing II	
GIS 4860	Internet Mapping	
Total Credits		48

Minimum number of credits required: 48

Students may choose from the elective options above, or they may work with their advisor to choose electives.

A satisfactory quality of achievement with a grade point average of "B" (3.0) or better is required in graduate coursework accepted for the degree. The average is determined on the basis of the University's grading system. In no case, may more than one-fourth of the hours accepted toward the degree be of "C" grade. A grade lower than "C" renders the credit unacceptable for meeting degree requirements. Students must earn a grade of B- or better in the Capstone Project or Capstone Seminar.

Master of Science in Information and Communications Technology with a Concentration in Information Systems Security

Degree Requirements

Code	Title	Credits
Core coursework requirements		
ICT 4000	ICT Business Foundations	4
ICT 4005	ICT Technical Foundations	4
ICT 4010	Enterprise Architecture	4
ICT 4901	Capstone Project	4
or ICT 4902	Capstone Seminar	
or ICT 4904		
Concentration requirements		
ICT 4300	Web Enabled Information Systems	4
ICT 4605	Principles of Information Security	4
ICT 4615	Computer and Physical Security	4
ICT 4845	Network Security with Lab	4
Elective requirements (Choose four courses):		16
ICT 4405	Database Design and Implementation	
ICT 4505	Website Design and Management	
ICT 4610	TCP/IP Networks	
ICT 4670	Disaster Recovery and Operations Security	
ICT 4675	Information Systems Security in Healthcare	
ICT 4680	Principles of Cryptography	
ICT 4685	Cloud and Internet Law	
ICT 4690	Computer Forensics with Lab	
ICT 4695	Application Security	
ICT 4800	Network Communications and the Internet	
Total Credits		48

Minimum number of credits required: 48

Students may choose from the elective options above, or they may work with their advisor to choose electives.

A satisfactory quality of achievement with a grade point average of "B" (3.0) or better is required in graduate coursework accepted for the degree. The average is determined on the basis of the University's grading system. In no case, may more than one-fourth of the hours accepted toward the degree be of "C" grade. A grade lower than "C" renders the credit unacceptable for meeting degree requirements. Students must earn a grade of B- or better in the Capstone Project or Capstone Seminar.

Master of Science in Information and Communications Technology with a Concentration in Mobile Application Development

Degree Requirements

Code	Title	Credits
Core coursework requirements		
ICT 4000	ICT Business Foundations	4
ICT 4005	ICT Technical Foundations	4
ICT 4010	Enterprise Architecture	4
ICT 4901	Capstone Project	4
or ICT 4902	Capstone Seminar	
or ICT 4904		
Concentration requirements		
ICT 4510	Advanced Website Design and Management	4
ICT 4576	Native Application Development on Mobile Devices	4
ICT 4580	Mobile Application Development with Web Standards	4
And choose one of the following:		
ICT 4515	Usability Design for Websites	4
or ICT 4555	Introduction to Animate CC	
or ICT 4561	Web Development with PHP	
or ICT 4570	Web Scripting with JavaScript	
Elective requirements (Choose four courses):		16
ICT 4100	Principles of Project Management	
ICT 4300	Web Enabled Information Systems	
ICT 4305	Object-Oriented Methods	
ICT 4310	Distributed Computing	
ICT 4315	Object-Oriented Programming	
ICT 4351	.NET Programming with C#	
ICT 4361	Java Programming	
ICT 4370	Python Programming	
ICT 4400	Database Administration	
ICT 4405	Database Design and Implementation	
ICT 4505	Website Design and Management	
ICT 4515	Usability Design for Websites	
ICT 4540	XML and Data in Application Development	
ICT 4555	Introduction to Animate CC	
ICT 4560	Web Graphics Production	
ICT 4561	Web Development with PHP	
ICT 4570	Web Scripting with JavaScript	
ICT 4585	Web Development with Ruby on Rails	
ICT 4605	Principles of Information Security	
ICT 4680	Principles of Cryptography	
ICT 4695	Application Security	
ICT 4840	Next Generation Wireless Networks and Services	
COMM 4324	Marketing Analytics	
Total Credits		48

Minimum number of credits required: 48

Students may choose from the elective options above, or they may work with their advisor to choose electives.

A satisfactory quality of achievement with a grade point average of "B" (3.0) or better is required in graduate coursework accepted for the degree. The average is determined on the basis of the University's grading system. In no case, may more than one-fourth of the hours accepted toward the degree

be of "C" grade. A grade lower than "C" renders the credit unacceptable for meeting degree requirements. Students must earn a grade of B- or better in the Capstone Project or Capstone Seminar.

Master of Science in Information and Communications Technology with a Concentration in Project Management

Degree Requirements

Code	Title	Credits
Core coursework requirements		
ICT 4000	ICT Business Foundations	4
ICT 4005	ICT Technical Foundations	4
ICT 4010	Enterprise Architecture	4
ICT 4901	Capstone Project	4
or ICT 4902	Capstone Seminar	
or ICT 4904		
Concentration requirements		
ICT 4100	Principles of Project Management	4
ICT 4105	Project Contracts and Procurement	4
ICT 4110	Project Management Tools and Techniques	4
ICT 4115	Project Management Dynamics	4
Elective requirements (Choose four courses):		16
ICT 4015	Managing Technology for Strategic Value	
ICT 4020	Business Forecasting and Planning	
ICT 4025	Technology and Innovation Management	
ICT 4045	Information Technology Service Assurance	
ICT 4155	Strategic Alliances in the Technology Sector	
ICT 4160	Advanced Methods for Complex Projects	
ICT 4165	Project Collaboration with SharePoint	
ICT 4170	Agile Techniques and Practices in Project Management	
ICT 4605	Principles of Information Security	
ICT 4685	Cloud and Internet Law	
ICT 4815	Managing Global Telecommunications Projects	
Total Credits		48

Minimum number of credits required: 48

Students may choose from the elective options above, or they may work with their advisor to choose electives.

A satisfactory quality of achievement with a grade point average of "B" (3.0) or better is required in graduate coursework accepted for the degree. The average is determined on the basis of the University's grading system. In no case, may more than one-fourth of the hours accepted toward the degree be of "C" grade. A grade lower than "C" renders the credit unacceptable for meeting degree requirements. Students must earn a grade of B- or better in the Capstone Project or Capstone Seminar.

Master of Science in Information and Communications Technology with a Concentration in Software Design and Programming

Degree Requirements

Code	Title	Credits
Core coursework requirements		
ICT 4000	ICT Business Foundations	4
ICT 4005	ICT Technical Foundations	4
ICT 4010	Enterprise Architecture	4
ICT 4901	Capstone Project	4
or ICT 4902	Capstone Seminar	
or ICT 4904		

Concentration requirements

Code	Title	Credits
ICT 4300	Web Enabled Information Systems	4
ICT 4305	Object-Oriented Methods	4
ICT 4310	Distributed Computing	4
ICT 4315	Object-Oriented Programming	4
Elective requirements (Choose four courses):		**16**
ICT 4100	Principles of Project Management	
ICT 4351	.NET Programming with C#	
ICT 4361	Java Programming	
ICT 4370	Python Programming	
ICT 4400	Database Administration	
ICT 4405	Database Design and Implementation	
ICT 4505	Website Design and Management	
ICT 4510	Advanced Website Design and Management	
ICT 4515	Usability Design for Websites	
ICT 4540	XML and Data in Application Development	
ICT 4555	Introduction to Animate CC	
ICT 4561	Web Development with PHP	
ICT 4570	Web Scripting with JavaScript	
ICT 4576	Native Application Development on Mobile Devices	
ICT 4580	Mobile Application Development with Web Standards	
ICT 4585	Web Development with Ruby on Rails	
ICT 4605	Principles of Information Security	
ICT 4680	Principles of Cryptography	
ICT 4695	Application Security	
Total Credits		**48**

Minimum number of credits required: 48

Students may choose from the elective options above, or they may work with their advisor to choose electives.

A satisfactory quality of achievement with a grade point average of "B" (3.0) or better is required in graduate coursework accepted for the degree. The average is determined on the basis of the University's grading system. In no case, may more than one-fourth of the hours accepted toward the degree be of "C" grade. A grade lower than "C" renders the credit unacceptable for meeting degree requirements. Students must earn a grade of B- or better in the Capstone Project or Capstone Seminar.

Master of Science in Information and Communications Technology with a Concentration in Technology Management

Degree Requirements

Code	Title	Credits
Core coursework requirements		
ICT 4000	ICT Business Foundations	4
ICT 4005	ICT Technical Foundations	4
ICT 4010	Enterprise Architecture	4
ICT 4901	Capstone Project	4
or ICT 4902	Capstone Seminar	
or ICT 4904		
Concentration requirements		
ICT 4015	Managing Technology for Strategic Value	4
ICT 4020	Business Forecasting and Planning	4
ICT 4025	Technology and Innovation Management	4
ICT 4100	Principles of Project Management	4
Elective requirements (Choose four courses):		**16**
ICT 4045	Information Technology Service Assurance	

ICT 4105	Project Contracts and Procurement
ICT 4110	Project Management Tools and Techniques
ICT 4115	Project Management Dynamics
ICT 4155	Strategic Alliances in the Technology Sector
ICT 4160	Advanced Methods for Complex Projects
ICT 4165	Project Collaboration with SharePoint
ICT 4170	Agile Techniques and Practices in Project Management
ICT 4605	Principles of Information Security
ICT 4675	Information Systems Security in Healthcare
ICT 4685	Cloud and Internet Law
ICT 4815	Managing Global Telecommunications Projects
COMM 4324	Marketing Analytics
Total Credits	48

Minimum number of credits required: 48

Students may choose from the elective options above, or they may work with their advisor to choose electives.

A satisfactory quality of achievement with a grade point average of "B" (3.0) or better is required in graduate coursework accepted for the degree. The average is determined on the basis of the University's grading system. In no case, may more than one-fourth of the hours accepted toward the degree be of "C" grade. A grade lower than "C" renders the credit unacceptable for meeting degree requirements. Students must earn a grade of B- or better in the Capstone Project or Capstone Seminar.

Master of Science in Information and Communications Technology with a Concentration in Telecommunications Technology
Degree Requirements

Code	Title	Credits
Core coursework requirements		
ICT 4000	ICT Business Foundations	4
ICT 4005	ICT Technical Foundations	4
ICT 4010	Enterprise Architecture	4
ICT 4901	Capstone Project	4
or ICT 4902	Capstone Seminar	
or ICT 4904		
Concentration requirements		
ICT 4800	Network Communications and the Internet	4
ICT 4830	Broadband Wireless Networks	4
ICT 4840	Next Generation Wireless Networks and Services	4
ICT 4845	Network Security with Lab	4
Elective requirements (Choose four courses):		16
ICT 4015	Managing Technology for Strategic Value	
ICT 4020	Business Forecasting and Planning	
ICT 4045	Information Technology Service Assurance	
ICT 4100	Principles of Project Management	
ICT 4155	Strategic Alliances in the Technology Sector	
ICT 4300	Web Enabled Information Systems	
ICT 4400	Database Administration	
ICT 4405	Database Design and Implementation	
ICT 4410	Data Warehousing Design	
ICT 4415	Database Backup and Recovery with Lab	
ICT 4461	SQL Server with Lab	
ICT 4505	Website Design and Management	
ICT 4605	Principles of Information Security	

ICT 4610	TCP/IP Networks	
ICT 4680	Principles of Cryptography	
ICT 4685	Cloud and Internet Law	
ICT 4695	Application Security	
ICT 4815	Managing Global Telecommunications Projects	
ICT 4835	Advanced Network Technologies	
GIS 4520	GIS in Telecommunications	
Total Credits		48

Minimum number of credits required: 48

Students may choose from the elective options above, or they may work with their advisor to choose electives.

A satisfactory quality of achievement with a grade point average of "B" (3.0) or better is required in graduate coursework accepted for the degree. The average is determined on the basis of the University's grading system. In no case, may more than one-fourth of the hours accepted toward the degree be of "C" grade. A grade lower than "C" renders the credit unacceptable for meeting degree requirements. Students must earn a grade of B- or better in the Capstone Project or Capstone Seminar.

Master of Science in Information and Communications Technology with a Concentration in Web Design and Development

Degree Requirements

Code	Title	Credits
Core coursework requirements		
ICT 4000	ICT Business Foundations	4
ICT 4005	ICT Technical Foundations	4
ICT 4010	Enterprise Architecture	4
ICT 4901	Capstone Project	4
or ICT 4902	Capstone Seminar	
or ICT 4904		
Concentration requirements		
ICT 4300	Web Enabled Information Systems	4
ICT 4505	Website Design and Management	4
ICT 4510	Advanced Website Design and Management	4
ICT 4515	Usability Design for Websites	4
Elective requirements (Choose four courses):		16
ICT 4100	Principles of Project Management	
ICT 4305	Object-Oriented Methods	
ICT 4310	Distributed Computing	
ICT 4370	Python Programming	
ICT 4400	Database Administration	
ICT 4405	Database Design and Implementation	
ICT 4540	XML and Data in Application Development	
ICT 4555	Introduction to Animate CC	
ICT 4560	Web Graphics Production	
ICT 4561	Web Development with PHP	
ICT 4570	Web Scripting with JavaScript	
ICT 4576	Native Application Development on Mobile Devices	
ICT 4580	Mobile Application Development with Web Standards	
ICT 4585	Web Development with Ruby on Rails	
ICT 4605	Principles of Information Security	
ICT 4680	Principles of Cryptography	
ICT 4695	Application Security	
COMM 4324	Marketing Analytics	

Code	Title	
COMM 4327	Digital Content Creation	
Total Credits		**48**

Minimum number of credits required: 48

Students may choose from the elective options above, or they may work with their advisor to choose electives.

A satisfactory quality of achievement with a grade point average of "B" (3.0) or better is required in graduate coursework accepted for the degree. The average is determined on the basis of the University's grading system. In no case, may more than one-fourth of the hours accepted toward the degree be of "C" grade. A grade lower than "C" renders the credit unacceptable for meeting degree requirements. Students must earn a grade of B- or better in the Capstone Project or Capstone Seminar.

Certificate in Information and Communications Technology with a Concentration in Database Design and Administration
Program Requirements

Code	Title	Credits
Concentration requirements		
ICT 4300	Web Enabled Information Systems	4
ICT 4400	Database Administration	4
ICT 4405	Database Design and Implementation	4
ICT 4410	Data Warehousing Design	4
Elective requirements (Choose two courses):		8
ICT 4000	ICT Business Foundations	
ICT 4005	ICT Technical Foundations	
ICT 4100	Principles of Project Management	
ICT 4305	Object-Oriented Methods	
ICT 4415	Database Backup and Recovery with Lab	
ICT 4451	Database Programming: Oracle PL/SQL	
ICT 4461	SQL Server with Lab	
ICT 4462	Transact - SQL Programming	
ICT 4485	NoSQL Databases	
ICT 4505	Website Design and Management	
ICT 4540	XML and Data in Application Development	
ICT 4605	Principles of Information Security	
ICT 4680	Principles of Cryptography	
ICT 4695	Application Security	
Total Credits		**24**

Minimum number of credits required: 24

Certificate in Information and Communications Technology with a Concentration in Information Systems Security
Program Requirements

Code	Title	Credits
Concentration requirements		
ICT 4300	Web Enabled Information Systems	4
ICT 4605	Principles of Information Security	4
ICT 4615	Computer and Physical Security	4
ICT 4845	Network Security with Lab	4
Elective requirements (Choose two courses):		8
ICT 4000	ICT Business Foundations	
ICT 4005	ICT Technical Foundations	
ICT 4100	Principles of Project Management	

ICT 4610	TCP/IP Networks	
ICT 4670	Disaster Recovery and Operations Security	
ICT 4675	Information Systems Security in Healthcare	
ICT 4680	Principles of Cryptography	
ICT 4685	Cloud and Internet Law	
ICT 4690	Computer Forensics with Lab	
ICT 4695	Application Security	
ICT 4800	Network Communications and the Internet	
Total Credits		24

Minimum number of credits required: 24

Certificate in Information and Communications Technology with a Concentration in Mobile Application Development

Program Requirements

Code	Title	Credits
Concentration requirements		
ICT 4510	Advanced Website Design and Management	4
ICT 4576	Native Application Development on Mobile Devices	4
ICT 4580	Mobile Application Development with Web Standards	4
ICT 4515	Usability Design for Websites	4
or ICT 4555	Introduction to Animate CC	
or ICT 4561	Web Development with PHP	
or ICT 4570	Web Scripting with JavaScript	
Elective requirements (Choose two courses):		8
ICT 4000	ICT Business Foundations	
ICT 4100	Principles of Project Management	
ICT 4300	Web Enabled Information Systems	
ICT 4305	Object-Oriented Methods	
ICT 4310	Distributed Computing	
ICT 4315	Object-Oriented Programming	
ICT 4351	.NET Programming with C#	
ICT 4361	Java Programming	
ICT 4370	Python Programming	
ICT 4400	Database Administration	
ICT 4405	Database Design and Implementation	
ICT 4505	Website Design and Management	
ICT 4515	Usability Design for Websites	
ICT 4540	XML and Data in Application Development	
ICT 4555	Introduction to Animate CC	
ICT 4560	Web Graphics Production	
ICT 4561	Web Development with PHP	
ICT 4570	Web Scripting with JavaScript	
ICT 4585	Web Development with Ruby on Rails	
ICT 4605	Principles of Information Security	
ICT 4680	Principles of Cryptography	
ICT 4695	Application Security	
ICT 4840	Next Generation Wireless Networks and Services	
COMM 4324	Marketing Analytics	
Total Credits		24

Minimum number of credits required: 24

Certificate in Information and Communications Technology with a Concentration in Project Management

Program Requirements

Code	Title	Credits
Concentration requirements		
ICT 4100	Principles of Project Management	4
ICT 4105	Project Contracts and Procurement	4
ICT 4110	Project Management Tools and Techniques	4
ICT 4115	Project Management Dynamics	4
Elective requirements (Choose two courses):		8
ICT 4000	ICT Business Foundations	
ICT 4005	ICT Technical Foundations	
ICT 4015	Managing Technology for Strategic Value	
ICT 4020	Business Forecasting and Planning	
ICT 4025	Technology and Innovation Management	
ICT 4045	Information Technology Service Assurance	
ICT 4155	Strategic Alliances in the Technology Sector	
ICT 4160	Advanced Methods for Complex Projects	
ICT 4165	Project Collaboration with SharePoint	
ICT 4170	Agile Techniques and Practices in Project Management	
ICT 4605	Principles of Information Security	
ICT 4685	Cloud and Internet Law	
ICT 4815	Managing Global Telecommunications Projects	
Total Credits		24

Minimum number of credits required: 24

Certificate in Information and Communications Technology with a Concentration in Software Design and Programming

Program Requirements

Code	Title	Credits
Concentration requirements		
ICT 4300	Web Enabled Information Systems	4
ICT 4305	Object-Oriented Methods	4
ICT 4310	Distributed Computing	4
ICT 4315	Object-Oriented Programming	4
Elective requirements (Choose two courses):		8
ICT 4000	ICT Business Foundations	
ICT 4005	ICT Technical Foundations	
ICT 4100	Principles of Project Management	
ICT 4351	.NET Programming with C#	
ICT 4361	Java Programming	
ICT 4370	Python Programming	
ICT 4400	Database Administration	
ICT 4405	Database Design and Implementation	
ICT 4505	Website Design and Management	
ICT 4510	Advanced Website Design and Management	
ICT 4515	Usability Design for Websites	
ICT 4540	XML and Data in Application Development	
ICT 4555	Introduction to Animate CC	
ICT 4561	Web Development with PHP	

ICT 4570	Web Scripting with JavaScript	
ICT 4576	Native Application Development on Mobile Devices	
ICT 4580	Mobile Application Development with Web Standards	
ICT 4585	Web Development with Ruby on Rails	
ICT 4605	Principles of Information Security	
ICT 4680	Principles of Cryptography	
ICT 4695	Application Security	
GIS 4080	Python Programming in GIS	
Total Credits		24

Minimum number of credits required: 24

Certificate in Information and Communications Technology with a Concentration in Technology Management

Program Requirements

Code	Title	Credits
Concentration requirements		
ICT 4015	Managing Technology for Strategic Value	4
ICT 4020	Business Forecasting and Planning	4
ICT 4025	Technology and Innovation Management	4
ICT 4100	Principles of Project Management	4
Elective requirements (Choose two courses):		8
ICT 4000	ICT Business Foundations	
ICT 4005	ICT Technical Foundations	
ICT 4045	Information Technology Service Assurance	
ICT 4105	Project Contracts and Procurement	
ICT 4110	Project Management Tools and Techniques	
ICT 4115	Project Management Dynamics	
ICT 4155	Strategic Alliances in the Technology Sector	
ICT 4160	Advanced Methods for Complex Projects	
ICT 4165	Project Collaboration with SharePoint	
ICT 4170	Agile Techniques and Practices in Project Management	
ICT 4605	Principles of Information Security	
ICT 4685	Cloud and Internet Law	
ICT 4815	Managing Global Telecommunications Projects	
COMM 4324	Marketing Analytics	
Total Credits		24

Minimum number of credits required: 24

Certificate in Information and Communications Technology with a Concentration in Telecommunications Technology

Program Requirements

Code	Title	Credits
Concentration requirements		
ICT 4800	Network Communications and the Internet	4
ICT 4830	Broadband Wireless Networks	4
ICT 4840	Next Generation Wireless Networks and Services	4
ICT 4845	Network Security with Lab	4
Elective requirements (Choose two courses):		8
ICT 4000	ICT Business Foundations	
ICT 4005	ICT Technical Foundations	

ICT 4015	Managing Technology for Strategic Value	
ICT 4020	Business Forecasting and Planning	
ICT 4045	Information Technology Service Assurance	
ICT 4100	Principles of Project Management	
ICT 4155	Strategic Alliances in the Technology Sector	
ICT 4160	Advanced Methods for Complex Projects	
ICT 4605	Principles of Information Security	
ICT 4610	TCP/IP Networks	
ICT 4685	Cloud and Internet Law	
ICT 4815	Managing Global Telecommunications Projects	
ICT 4835	Advanced Network Technologies	
GIS 4520	GIS in Telecommunications	
Total Credits		24

Minimum number of credits required: 24

Certificate in Information and Communications Technology with a Concentration in Web Design and Development

Program Requirements

Code	Title	Credits
Concentration requirements		
ICT 4300	Web Enabled Information Systems	4
ICT 4505	Website Design and Management	4
ICT 4510	Advanced Website Design and Management	4
ICT 4515	Usability Design for Websites	4
Elective requirements (Choose two courses):		8
ICT 4000	ICT Business Foundations	
ICT 4005	ICT Technical Foundations	
ICT 4100	Principles of Project Management	
ICT 4305	Object-Oriented Methods	
ICT 4310	Distributed Computing	
ICT 4370	Python Programming	
ICT 4400	Database Administration	
ICT 4405	Database Design and Implementation	
ICT 4540	XML and Data in Application Development	
ICT 4555	Introduction to Animate CC	
ICT 4560	Web Graphics Production	
ICT 4561	Web Development with PHP	
ICT 4570	Web Scripting with JavaScript	
ICT 4576	Native Application Development on Mobile Devices	
ICT 4580	Mobile Application Development with Web Standards	
ICT 4585	Web Development with Ruby on Rails	
ICT 4605	Principles of Information Security	
ICT 4680	Principles of Cryptography	
ICT 4695	Application Security	
COMM 4324	Marketing Analytics	
COMM 4327	Digital Content Creation	
Total Credits		24

Minimum number of credits required: 24

Courses

ICT 20095 ICT Transfer (1-12 Credits)

ICT 4000 ICT Business Foundations (4 Credits)
This course provides an overview of the relationships between business needs and Information & Communications Technology solutions. The course focuses on fundamental attributes of business research and analysis in the ICT field. Applying appropriate research methods is a critical course requirement. Students demonstrate the critical skills required to define a problem, establish a business and technical context, perform appropriate research, propose and analyze alternative solutions, identify decision criteria, and make recommendations based on such considerations as benefits, technical feasibility, costs, risks, and resources. Students assess the relevance of research findings, considering the credibility of the source, relevance to the research question, and validity of the underlying data. Taking into account current industry trends and customer/user needs, students apply the product development process to create a product or service proposal, including business requirements and a detailed business case. The course establishes the professional and academic framework for the ICT master's degree program, setting a relevant industry context for all ICT concentrations.

ICT 4005 ICT Technical Foundations (4 Credits)
This course provides a substantive review of the technology at the core of the ICT industry. Coverage includes hardware, networking technology, databases, information services, applications, and content in enterprise contexts. The application development process is briefly reviewed. A framework is developed around data at rest, data in transit, and data being processed. This framework is used to detail the roles of a variety of hardware and software artifacts, and their use in the production, processing, protection, and use of organizational information. The role of the ICT user interface and web systems in providing user access to content anytime anywhere is reviewed. The security requirements associated with a variety of information types are introduced, along with the current best practices used in information security.

ICT 4010 Enterprise Architecture (4 Credits)
In this course, students learn how to effectively and efficiently integrate information and communications technologies to support business goals. The course provides an overview of the global, enterprise-wide architectural framework that drives business decisions regarding selection and implementation of ICT systems and solutions. Topics include supporting and transforming Global Value Chains, e-business designs; creating enterprise architecture; and the various methodologies, tools and techniques used in the design and implementation of the enterprise architecture. The course encompasses all aspects of information and communications technology, including data networks, applications, operating systems, database systems, telecommunications systems, and hardware components in the context of a total enterprise-wide framework.

ICT 4015 Managing Technology for Strategic Value (4 Credits)
In this course, students acquire an in-depth understanding of the key management skills necessary to manage technology for strategic value. It concentrates on providing in-depth knowledge of strategic planning, the role of technology in business, and business process automation. It also provides students with the management skills and tools to prioritize technology investments, and manage technology products and projects. Topics include strategic planning and business alignment, managing business applications, business process automation, the role of web 2.0 in business processes, technology management, budgeting and capital investment prioritization, and build/buy decision-making in regards to custom-built and off-the-shelf solutions.

ICT 4020 Business Forecasting and Planning (4 Credits)
Business forecasting and planning brings together a wide diversity of skills: economic, financial, marketing, and technical analysis. This course brings together these concepts and extends prior coursework with coverage of budgeting, finance, costing, business planning, revenue forecasting, profit and loss statements, and balance sheet analysis as applied to information systems and services. Coverage includes the economics of software and other intellectual property, network effects, usage and sharing effects, sunk costs and monopoly effects, capacity and resource planning issues, and an introduction to the related regulatory issues. Students develop budgets or business plans for several increasingly difficult scenarios addressing a range of technology applications and services.

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. Prerequisites: ICT 4010, ICT 4015, ICT 4020, ICT 4100.

ICT 4030 Enterprise Architecture Frameworks (4 Credits)
This course covers the application of Enterprise Architecture (EA) frameworks as systems of methods, tools, and standards for transforming the operations of business, non-profit, and government organizations. The course concentrates on TOGAF, The Open Group Architecture Framework, as the primary instructional vehicle, but also outlines other EA frameworks and illustrates their individual purposes. The course demonstrates how EA frameworks can be combined and customized to meet specific objectives. The class starts with a high-level overview of EA, TOGAF, and other EA frameworks, then moves toward covering each component of the TOGAF framework. As the course moves through each component of TOGAF, key concepts such as governance, building blocks, views, viewpoints, and stakeholders are presented in context. Students will choose and apply EA frameworks with transition planning to current industry case studies and scenarios.

ICT 4035 Applied Enterprise Architecture Solutions (4 Credits)
This course addresses how Enterprise Architecture (EA) frameworks and associated methodologies can be combined and customized for targeted organizations for their specific, overarching EA program/capability. It then lays out how to construct a strategic architecture initiative using the customized EA capability, which will include the use of full life cycle transformation activities, leading EA graphical languages and a variety of EA planning and modeling tools. The first half of the course will provide students with the information necessary for them to develop their customized EA capability. The second half will focus on applying the capability for a robust business transformation initiative in their respective final projects. Prerequisite: ICT 4030.

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 is designed to provide students with practical skills in project management and the students who are continuing in the Project Management course sequence with a framework for the concepts and tools covered in the remainder of the program. The various elements of the project management processes, tools and techniques are explored, applying the software used in managing projects. Topics include a review of processes to initiate, plan, execute, monitor and control, and close a project. Project integration, scope (including requirements), time, cost management, and planning human resources are emphasized. Students learn project management skills through hands-on exercises using project management tools and techniques and project management software to emphasize the real world of managing a project.

ICT 4105 Project Contracts and Procurement (4 Credits)
This course is designed to provide students with practical skills in project contracts and procurement. This course introduces the various elements of the contract and procurement process, including exposure to procurement plans, Request for Information (RFI), Request for Quote (RFQ) and Request for Proposal (RFP), as well as the various types of contracts and change order procedures. The course builds upon the framework from the remainder of the program. Topics include how to develop a procurement plan, what type of RFs to use and why, selection criteria for vendors, and contract selection. Students learn project management skills through hands-on exercises developing procurement plans, RFx's and contracts. No prerequisites.

ICT 4110 Project Management Tools and Techniques (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 (prerequisite course). 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. Prerequisite: ICT 4100 or equivalent knowledge.

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. Prerequisites: ICT 4100 and ICT 4110.

ICT 4120 Lean Six Sigma-Getting Started (4 Credits)
Students use Lean tools and techniques to define and scope a problem, determine project objectives and benefits, and create a project charter. The students also learn to define the 'as is' process, validate the measurement system and measure outputs, and quantify process performance.

ICT 4125 Lean Six Sigma-Analyze (4 Credits)
Students apply Lean tools and techniques to identify potential causes (x's), investigate the significance of x's, identify significant causes, and provide a preliminary definition of process outcomes as a function of causes [y=f(x)].

ICT 4130 Lean Six Sigma: Improve and Control (4 Credits)
Students apply Lean tools and techniques to generate potential solutions, select and test a solution, develop an implementation plan, and create a control and monitoring plan. The students also learn the methods and techniques for implementing a full scale solution and finalizing transition.

ICT 4155 Strategic Alliances in the Technology Sector (4 Credits)
Strategic alliances are one of the key drivers in today's global economy and 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. It also explores strategies for managing profitably and exploiting these external business relationships. Case studies will be an integral part of the learning experience. Successful and unsuccessful alliances will be analyzed 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)
This course explores the planning and execution challenges that often cause complex projects to fail. The course provides a historical perspective regarding project management practices, and reviews evidence regarding trends in project outcomes. For example, despite the use of commonly accepted methods for project management and systems engineering, the success rate of NASA and DoD programs, as measured by schedule, budget, and requirements performance, is trending downward. The evidence shows similar trends in commercial industries (e.g., the Airbus A380 and Boeing 787 aircraft programs). The course addresses why the methods embodied in the Project Management Institute's (PMI) A Guide to the Project Management Body of Knowledge (PMBOK Guide) 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. The instructor will host online reviews of readings and discussion. Students will learn and leverage visual modeling and simulation tools for the design of complex projects. Participation is voluntary, but recommended. Methods to handle complex, concurrent, and mutual dependencies across organizations and cultures will be applied. Based on case studies, the instructor will introduce Project Design methods, including student access to TeamPort project modeling and simulation software. The course culminates with teams in an online 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. Prerequisite: ICT 4100 or equivalent experience.

ICT 4165 Project Collaboration with SharePoint (4 Credits)
This course focuses on the role of collaboration as a critical success factor in project planning and execution. Complex projects typically entail cross-functional teams that are often geographically distributed, culturally diverse, and require collaboration across both organizational and corporate boundaries. This course covers best collaboration practices and the use of collaborative websites to facilitate communication, create shared understanding of processes and deliverable, and apply tools to achieve successful project completion. Hands-on assignments are used to illustrate how collaborative sites allow a project team to post, edit and jointly work on documents of all types, such as project charters, project plans, WBS, requirements, budgets, schedules, procurement activities and closeout activities. Students collaborate within the course to learn how collaborative sites can be used to control project documentation and enforce the security levels associated with those documents. Students also learn how these sites can be used for such activities as assigning tasks, building a project calendar, setting up logs for gathering information, and performing other typical project management duties. The lab portion of the courses uses SharePoint as a template and shows how to set up a site to create folders, lists, tasks lists, calendars, and set the associated security levels. A SharePoint site is created for each student and students have access to both the class site and their individual sites.

ICT 4170 Agile Techniques and Practices in Project Management (4 Credits)
Is the Agile vs. traditional project management debate over? At least in the world of software development, the debate is largely over, as evidenced by the widespread adoption of Agile methods. For example, according to Gartner, in 2012 Agile development methodologies will be used in 80 percent of all software development projects. As the term implies, however, the techniques and best practices for the successful application of Agile project management processes are not static, they will continue to evolve. And, Agile principles and practices are used across many project domains, each with their own unique characteristics and challenges. So, best Agile project management practices will continue to be dynamic. 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. The course content, in addition to reading assignments, uses practical assignments such as case studies, projects, and simulations to provide applied experience with Agile practices.

ICT 4300 Web Enabled Information Systems (4 Credits)
This course is an introduction to the design of web enabled information systems. The course reviews modern design and programming principles, introduces database design and object oriented principles, and introduces security issues and best practices related to web application development. The course introduces object-oriented modeling methods, including use cases, class, and activity diagrams that describe the informational and behavioral content of a system's objects. Basic OOM design tools are introduced. 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 each of the following specialties: Software Design and Programming, Database Design and Administration, Web Design and Development, and Information Systems Security.

ICT 4305 Object-Oriented Methods (4 Credits)
This course introduces the object-oriented view of software analysis, modeling, and design. It defines all of the relevant concepts needed to understand the paradigm. A complete graphical notational scheme is taught for the purpose of diagramming objects and object interactions. The course covers the design, evolution, modification, and test/verifications phases of object-oriented development in some depth. Since project management plays a key role in the success of object-oriented development, its relation to the development process is discussed. The course also surveys the various object-oriented languages and tools available.

ICT 4310 Distributed Computing (4 Credits)
This course provides a practical introduction to client-server applications and programming. The course examines key aspects of client-server computing such as systems requirements for operating systems, middleware, networks, servers and clients. The course develops students' understanding of alternative client-server architectures to meet business requirements, the selection of application development tools, and the use of object-oriented analysis and design practices to implement client-server applications. Students also develop client applications using a variety of techniques. Prerequisite: ICT 4300.

ICT 4315 Object-Oriented Programming (4 Credits)
This course covers modern programming techniques using object-oriented methods. The course familiarizes the student with development tools and the syntax of a programming language by developing simple programs that use control flow techniques and basic input/output techniques. Basic methods to harden code against malicious attack are introduced, and basic verification techniques presented. Prerequisites: ICT 4300 and ICT 4305.

ICT 4351 .NET Programming with C# (4 Credits)
Students identify and describe the fundamentals of the .NET architecture, explain various .NET components, their respective responsibilities and functions, identify and explain .NET design issues and development solutions; identify and describe the fundamental .NET components; explain CLR execution, and have some familiarity with predominant .NET languages.

ICT 4361 Java Programming (4 Credits)
This course enhances the student's experience in object-oriented design and software development by performing and discussing object-oriented design for re-use of general purpose applications and small Java applications, including using 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. The course also addresses the use of JAVA IDEs such as Eclipse and NetBeans. Note: This course does not address JavaScript. Prerequisites: ICT 4300, ICT 4305, 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. Prerequisite: ICT 4300.

ICT 4400 Database Administration (4 Credits)
This course introduces the roles and responsibilites, as well as the critical knowledge and skills needed to function as a database administrator. The course focuses on Oracle and Microsoft SQL Server, the two dominant global database platforms. Core components include installation and configuration of both database products and implementation of appropriate account priviledges. Lab environments are used for hands-on lab assignments in the course, as well as in subsequent courses in the ICT Database Design and Administration concentration. Primary job responsibilities of database administrators are examined, including monitoring, maintaining, and adminstering database platforms and schemas, while applying best practices in database security. Broader topics, such as metadata, business intelligence, and data warehousing are examined from an organizational perspective. Prerequisite: ICT 4300.

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). Prerequisites: ICT 4300, 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. Prerequisite: ICT 4400.

ICT 4415 Database Backup and Recovery with Lab (4 Credits)
This course explores basic database backup and recovery strategies and tactics using an Oracle database system. Topics include preparing backup, recovery and disaster plans, and performing complete and incomplete database recoveries using the Oracle Export/Import utility. Using hands-on activities and labs, students also gain experience with Oracle troubleshooting utilities, RMAN architecture and setting up Oracle standby databases. Prerequisites: ICT 4300, ICT 4400, ICT 4405.

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.

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. Prerequisites: ICT 4300 and 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.

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. Prerequisites: ICT 4300 and ICT 4405.

ICT 4505 Website Design and Management (4 Credits)
This course extends student 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 explore best-practices in information architecture (IA) and how to incorporate user-centered design (UCD) techniques as a standard practice in web design. Students also develop an understanding and working knowledge of Cascading Style Sheets (CSS). Through the use of readings, examples, hands-on projects, and discussions the class builds 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 experience working as active and contributing members of the class and knowledge-building community. Prerequisite: ICT 3500, ICT 4300 or equivalent experience.

ICT 4510 Advanced Website Design and Management (4 Credits)
This course explores advanced techniques for web programming using current client-side web technologies. Use of JavaScript, jQuery and Ajax are covered. HTML5 technologies such as Forms, Local Storage and Web workers are introduced. Students create an interactive website. This is a hands-on course where students apply what they learn as they learn it. Students demonstrate mastery of the materials by applying the principles introduced in class to laboratory exercise, class discussions, and projects. Prerequisite: ICT 4505.

ICT 4515 Usability Design for Websites (4 Credits)
This course expands the student's basic knowledge of Web page and website development (ICT 4505) by providing in-depth understanding of how to design Web applications with the user in mind. Students gain knowledge about how the fields of human factors engineering and psychology (e.g., visual perception, cognition, learning, and memory) relate to usability design as well as how usability assessments are conducted. Usability guidelines, design problems and design strengths, and best practices for common functions such as Web navigation, menus, scrolling, graphics and icons are explored. The class is a combination of lectures and lab experiences, culminating in the student's developing a website, conducting a usability evaluation, and reporting on the results and recommendations from the evaluation.

ICT 4520 User Experience: A Human-Centered Approach to Product Design (4 Credits)
This course is an introduction to User Experience (UX) design. The course will take theoretical and practical approaches to guiding students through the principles, practices, process, and tools to design usable, useful, and desirable experiences. Students will explore the methods for conducting UX research to determine needs, processes for designing products that meet those needs, and effective techniques for presenting designs to stakeholders. Throughout the process, students will consider the "why" behind each phase of the approach. The course will culminate in the application of UX best practices to build a functional prototype. Prerequisites: ICT 4505 Website Design & Development.

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. Prerequisite: ICT 4510 or previous programming experience.

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. Prerequisite: Knowledge of HTLM, ICT 4505, or previous programming experience.

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. Prerequisite: ICT 4300 or previous programming experience.

ICT 4580 Mobile Application Development with Web Standards (4 Credits)
This course enables students to take advantage of web standards (HTML5, CSS3, JavaScript) along with various popular frameworks and tools in the generation of both mobile web applications for the browser and packaged mobile applications for devices. We examine the fundamentals behind good user and interaction design when targeting mobile devices and see what is appropriate for implementation on these platforms. We also employ a popular cross-compilation tool to perform distribution onto multiple platforms. Prerequisite: previous programming experience.

ICT 4585 Web Development with Ruby on Rails (4 Credits)
Ruby is a dynamic, general-purpose, object-oriented programming language that has an associated web application framework, Rails. The Ruby on Rails (RoR) web application paradigm is powerful and flexible, and has been widely adopted by other frameworks. It allows for the rapid and agile creation of dynamic web applications with little of the overhead associated with other approaches. The student learns how to quickly develop, test, and deploy dynamic web applications using RoR. The student also learns how to manage both the user experience and a backend database from within the RoR framework. Prerequisite: ICT 4510 or previous programming experience.

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)2. 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. Prerequisite: ICT 4300.

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 Computer and Physical Security (4 Credits)
Controlling access to computers and controlling access to a building can no longer be viewed as two separate worlds. Today, IT access control and physical security need to be integrated if organizations are to be fully protected from threats. This course concentrates on seeing IT access control as integrated with physical security within an organization. Students investigate how various technologies and methodologies can work together to manage access to computer systems; how to manage elements of physical security; and the issues involved in creating a unified and complete enterprise security system. Security technologies to physically protect an organization's people, facility and resources, access control techniques and administration, identification and authentication techniques and methods of attack are emphasized. Prerequisites: ICT 4300 and ICT 4605.

ICT 4670 Disaster Recovery and Operations Security (4 Credits)
This course focuses on the planning and operations security required to effectively recover from natural disasters and security attacks and to ensure the operations and integrity of computer systems and staff. Topics include defining continuity requirements, choosing appropriate recovery strategies and understanding the key elements of a continuity plan. Students create a Business Continuity Plan including business impact analysis, recovery strategies, and recovery plan implementation. The course also provides an understanding of controls over resources, facilities, hardware, systems, and the people who create, modify, and use them. Control mechanisms and operations security "best practices" are identified.

ICT 4675 Information Systems Security in Healthcare (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 invovled. 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 futhering 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 one of the 10 domains required for the CISSP, and is a core component of all other recognized information security certifications. Surprisingly, it is 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: Advanced Encryption Standard (AES), the Secure Hash Algorithm (SHA), Digital Signatures and Message Authentication Codes, Diffie-Hellman Key Exchange, public key infrastructure (PKI), secure sockets layer (SSL), and IPsec among others Lecture and reading materials are reinforced by hands-on experimentation with cryptographic software tools., 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. Prerequisite: ICT 4605.

ICT 4685 Cloud and Internet Law (4 Credits)
The legal ramifications of Cloud Computing, Cyber and Internet Law are effecting dynamic change in our country and all throughout the world. This course explores the laws of the new paradigm of Cloud Computing, Cyber and Internet Law and describes the types of issues and concerns that exist. Such issues include the civil and criminal laws, rules and regulation, privacy issues, contractual agreements between parties (on many levels from providers in numerous different states and countries), the impact of differing cultural standards and mores from all over the world, and legal methods of protecting companies from these issues and worries in the world of Cloud Computing, the Internet and Cyber Law.

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.

ICT 4695 Application Security (4 Credits)
In this course, students explore the security principles and practices that apply to application software development throughout the entire software development lifecycle (SDLC). Topics include characteristics of secure and resilient applications, proven best practices for secure software, and designing for security and resilience. The course also provides an overview of programming best practices. Other topics include testing custom application, testing off-the-shelf commercial applications, implementing development security methodologies, and evaluating the models used to measure the maturity of software development organizations. Prerequisites: ICT 4300 and ICT 4605.

ICT 4701 Topics in Information and Communication Technology (4 Credits)
From time to time a special topics course may be offered that addresses a new issue, a developing concept, industry trends, or new technology.

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. Prerequisite: ICT 3800 or equivalent experience.

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 (required), ICT 4830 (strongly recommended).

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 or departmental permission.

ICT 4845 Network Security with Lab (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 OFDM, MIMO, mobile IP, WIMAX, LTE, 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. Important radio network concepts are addressed, including network design, cell selections and traffic concepts, mobility handoff signaling, radio resources management, location updates, roaming, as well as authentication and encryption. Prerequisite: ICT 4800 or departmental permission.

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 4903 Applied Capstone Seminar (4 Credits)
In the Applied Capstone Seminar, students propose, develop and deliver a cloud-based application that demonstrates the ability to apply the technical knowledge developed throughout their program of studies. In addition to demonstrating competence in applying what they have learned to date, students are challenged to expand their skills by virtue of the development environments, tools, and technologies they use to develop and deliver their projects. The primary deliverables are functional software, accompanied by representative design documents. As such, the project represents in microcosm the development processes, practices and deliverables that are typically entailed in producing robust, cloud-based software solutions. Although each student develops an individual project, the seminar also requires student collaboration via such activities as design reviews, quality reviews and peer exchanges on such topics as suggestions for solving problems and improving code. Prerequisite: To register for this course, a student must be accepted as a degree candidate, have completed at least 40 quarter-hours (including all core courses), and have a cumulative GPA of 3.0 or better. In addition, the student must be approved for registration by the course professor and the ICT Director. This seminar is limited to students in the Software Design & Programming, Web Design & Development, Mobile Application Development, and Database Design & Programming concentrations, and who are judged to have the requisite level of technical skills to be successful in this demanding seminar. A final grade of B- or better is required in this course to meet degree requirements. Students must complete the Applied Capstone Seminar in one quarter; no incomplete grades are permitted.

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.