COMPUTER SCIENCE AND INFORMATION TECHNOLOGY

DOMENICK J. PINTO, M.S., DIRECTOR
Phone: 203-371-7799
E-mail: pintod@sacredheart.edu

The University confers Master of Science degrees in Computer Information Science (MS), with tracks in Information Technology (IT), Computer Science (CS), and our newest track, Computer Gaming Design and Development. It also offers recognized graduate certificates in .NET Technology, Computer Gaming Design and Development, Cyber-Security, Database Design, Information Technology, IT and Network Security, and Web Development and Multimedia, which are some of the most lucrative and dynamic fields in the contemporary marketplace. Students choose their curriculum track based on their educational and career interests. Course content includes use of software such as VB.net 2012, Flash CS5, Fireworks CS5, Adobe Director 11.5, Java, C++, C#, ASP.net and content such as interactive multimedia, data communications, network security, Oracle, Artificial Intelligence (AI) and software engineering. Most classes are held in the evenings or on Saturday mornings in Fairfield, with some IT courses offered in Stamford and a few courses offered during the day. This structure accommodates working full-time students as well as those who may wish to participate in internships during the day.

Admission Requirements
Applications are processed on a rolling basis. Applicants should have a cumulative undergraduate GPA of 3.0 (on a 4.0 scale) or better. However, students may be admitted provisionally if their cumulative GPA is better than 2.5. Such students are allowed to take up to 12 credit hours and must maintain a 3.0 GPA in those courses. Provisional students who have completed 12 credit hours will then be considered for full matriculation. Except under unusual circumstances, applicants with a cumulative GPA of less than 2.5 are not admitted. A GPA of 3.0 is required to maintain good standing in the program and for graduation. All prospective students must complete an application for admission, submit official transcripts from each college or university attended (including Sacred Heart University) and forward two letters of recommendation and a résumé. Course waivers (to a maximum of nine credits) are granted on the basis of a student’s academic record.

Program Prerequisites
Students who do not have a bachelor’s degree in Computer Science or in a related field may be required to complete prerequisite coursework before full admission is granted. The number of courses is determined by which track a student chooses to pursue.

Computer Science Track

PREREQUISITE REQUIREMENTS
The following prerequisite courses may be required for those who wish to pursue the Computer Science track. All courses are to be completed with a grade of B or better. Additional prerequisites may be recommended by the program director. All students are required to complete the following coursework unless waived by the program director:

- CS 500 Introduction to Structured Programming
- CS 501 Introduction to Data Structures
- Calculus
Computer Science Master’s Degree Track Program
The Computer Science track is ideal for those who wish to pursue advanced study in areas of programming, data structures and fundamental computer language design.

REQUIREMENTS
This track requires a minimum of 36 credit hours of graduate-level coursework to complete. Students may be required to complete an additional 13 credit hours of prerequisite coursework. Students with an undergraduate degree in Computer or Information Science may receive waivers for some courses. Course waivers are not granted for work experience. A thesis is not required; however, for those students in the scientific track who elect to complete a thesis, they must enroll in CS 690 Thesis I and CS 691 Thesis II. Those who do not elect to complete a thesis must complete at least three credits of CS 670 Research Project Seminar. A degree will be granted upon satisfactory completion of all coursework and a favorable recommendation of the faculty responsible for CS 670 or 690/691.

Required Courses
- CS 551 Introduction to Object-Oriented Programming with Java
- CS 603 Database Design (Oracle)
- CS 604 Advanced Software Engineering
- CS 611 Operating/Multiprogramming Systems
- CS 614 Theory of Computation
- CS 615 Programming in Unix
- CS 622 Network Security I
- CS 623 Advanced Network Security
- CS 625 Cryptography
- CS 670 Research Project Seminar
- or
- CS 690/691 Thesis (I and/or II)

Electives
3–6 credits (see next page for list of electives)
Total: 36 credits

Information Technology Track

PREREQUISITE REQUIREMENTS
The following prerequisite courses may be required for those who wish to enter the Information Technology track. All courses are to be completed with a grade of B or better. Additional prerequisites may be recommended by the program director. Prerequisite courses cannot be taken concurrently.
- CS 500 Introduction to Structured Programming
- CS 501 Introduction to Data Structures

Prerequisites total: 6 credits

Information Technology Master’s Degree Track Program
The Information Technology (IT) track is a new, innovative program designed specifically to accommodate the dynamic demands of the contemporary marketplace. With the exponential growth of the Internet and the wide-ranging ramifications of the accompanying technologies, the IT track will prepare individuals for careers that utilize, or are affected by, the latest technological advances and methods of modern business and industry.

REQUIREMENTS
This track requires a minimum of 36 credit hours of graduate-level coursework. Students may be required to complete an additional six credit hours of prerequisite coursework. However, students with an undergraduate degree in Computer or Information Science
may receive waivers for some courses. Course waivers are not granted for work experience.

**Required Courses**

- CS 551 Introduction to Object-Oriented Programming with Java
- CS 552 Windows Interface Design (VB.net)
- CS 553 Web Design with Java Script
- CS 554 Fundamentals of Interactive Multimedia
- CS 601 Assembly Language Programming and Computer Systems
- CS 603 Database Design (Oracle)
- CS 620 Information Analysis and Systems Design
- CS 621 Principles of Data Communication
- CS 670 Research Project Seminar

Required courses total: 27 credits

**Elective Courses**

(Eight credits are required). A maximum of six credits can be an MBA (BU) offering. It is also at the discretion of the academic program director to approve any other CS or MBA course offering as an appropriate elective. The following is a partial list of electives:

- BU 651 Management of Global Telecommunications
- BU 652 Project/Program Management
- BU 653 International Electronic Commerce and the Internet
- CS 550 Dynamic Web Page Development
- CS 557 Web Programming with ASP.net
- CS 558 Advanced Topics in ASP.net
- CS 559 C#
- CS 560 Networking Applications
- CS 563 Flash Animation
- CS 564 Action Scripting
- CS 571 Advanced Computer Gaming
- CS 572 OOP with C# and Games
- CS 573 Advanced Game Programming
- CS 604 Advanced Software Engineering
- CS 611 Operating/Multiprogramming Systems
- CS 622 Network Security I
- CS 623 Advanced Network Security
- CS 624 Hands-on Network Security
- CS 626 Cyber-Security
- CS 635 Digital Forensics
- CS 640 Special Topics in Computer Science

Elective courses total: 9 credits
Degree total: 36 credits

**Computer Gaming Design and Development Master’s Degree Program Track**

This track in the MSCIS program is designed for the student who has:

- already completed an undergraduate track in Computer Gaming *or*
- an undergraduate degree in Computer Science *or*
- completed the graduate Gaming Design and Development certificate.

The objective of the track is to take the student beyond the rudiments of game design and development into more advanced Gaming or areas such as 3-D Game design and Game Design for mobile devices. It is intended that this track be structured for students who have pursued a CS track OR who have sufficient mathematical and programming credentials to successfully complete the required courses.
**PREREQUISITES: (3 CREDITS EACH)**
- CS 501  Data Structures
- CS 573  Advanced Game Programming or equivalent

**REQUIRED COURSES (ALL COURSES ARE 3 CREDITS)**
- CS 551  Introduction to Object-Oriented Programming with Java
- CS 603  Database Design (Oracle)
- CS 614  Theory of Computation
- CS 615  Programming in Unix
  or
- CS 611  Operating/Multiprogramming Systems
- CS 622  Network Security
- CS 661  Game Design and Development using 3-D
- CS 662  Game Design, Development, and Implementation
- CS 663  Game Design for Mobile Devices
- CS 664  Advanced Topics in Multiplayer Gaming
- CS 670  Research Project Seminar
  or
- CS 690-691  Thesis Work

Total required courses: 30 or 33 credits

Choose 2 CS electives (if non-thesis) or 1 CS elective (if thesis) from list below:
- CS 602  Advanced Data Structures and Algorithms
- CS 604  Advanced Software Engineering
- CS 623  Advanced Network Security
- CS 642  Securing the Client/Server (highly recommended elective)
  (or other electives approved by Program Director)

Total required elective course credits: 3 or 6
Total Credits for track: 36

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**Certificate Programs**

**.NET TECHNOLOGY CERTIFICATE**

The .NET Technology graduate certificate is a comprehensive and consistent programming model for building applications that can provide visually stunning user experiences and the ability to provide a multiple tiered approach to creating and delivering a variety of applications for web-based programming. This certificate will allow the student to work with and build projects in several of the most common and widely used .NET applications including VB.net, C# and ASP.net. All courses taken in this certificate program may be applied to a full MSCIS degree.

**Certificate Requirements**

The program requires the student to complete a minimum of twelve (12) semester credit hours of course work with a minimum cumulative GPA of 3.0. There are two prerequisites to the certificate: CS 500 and CS 501. All course credits earned in a certificate program may be applied to the master’s program.

**Prerequisite Courses (if required)**
- CS 500  Introduction to Structured Programming
- CS 501  Introduction to Data Structures

**Required Courses**
- CS 552  Windows Interface Design (VB.net)
- CS 603  Database Design (Oracle)
- CS 557  Web Programming with ASP.net

**Elective Courses (choose one)**
- CS 558  Advanced ASP.net
- CS 559  C#

Certificate Total: 12-18 credits (Depending on prerequisite)
COMPUTER GAMING DESIGN AND DEVELOPMENT CERTIFICATE

The graduate certificate in Computer Gaming Design and Development is designed for the graduate student who has not pursued a computer gaming track or major on the undergraduate level. It will give students an excellent introduction to the field of computer gaming design and development and courses taken may be applied to a full MS degree in either the IT, CS or a new Computer Gaming track which is expected to start in Spring 2012. This certificate is NOT designed for those students who already have significant course work in Computer Gaming.

Prerequisite Courses
CS 500 Introduction to Structured Programming
CS 501 Introduction to Data Structures

Required Courses
CS 571 Advanced Computer Gaming
CS 572 OOP with C# and Games
CS 573 Advanced Game Programming
CS 662 Game Design, Development and Implementation

Certificate Total: 12 credits

INFORMATION TECHNOLOGY CERTIFICATE

A student may choose to enroll in the Information Technology Graduate Certificate program to learn specific skills in the area of Information Technology. The certificate program is ideal for those who are undecided about committing to a full master’s degree program, but wish to pursue advanced study in this field.

Requirements
The program requires the student to complete a minimum of 12 semester credit hours of coursework, with a minimum cumulative GPA of 3.0. Students matriculated in the master’s program are not eligible for a graduate certificate. However, students who have successfully completed a graduate certificate may apply to the master’s program and may be able to use those credits earned in the certificate program toward the master’s degree. Contact the program director to determine which, if any, graduate certificate credits may apply. Graduate admissions procedures must be followed.

Prerequisite Courses
CS 500 Introduction to Structured Programming
CS 501 Introduction to Data Structures

Required Courses
CS 552 Windows Interface Design (VB.net)
CS 553 Web Design with Java Script
CS 603 Database Design (Oracle)
One elective from any available electives approved by program director

INTERACTIVE MULTIMEDIA CERTIFICATE

In response to the recent growth and use of multimedia applications in the modern business environment, this certificate has been explicitly designed for students who want to focus exclusively on the popular discipline of multimedia.

Requirements
The program requires the student to complete a minimum of 12 semester credit hours of coursework, with a minimum cumulative GPA of 3.0. Regular program prerequisites still apply (CS 500 Introduction to Structured Programming and CS 501 Introduction to Data Structures). Students matriculated in the master’s program are not eligible for a graduate certificate. However, students who have successfully completed a graduate certificate may apply to the master’s program and may be able to use those credits earned in the certificate
program toward the master's degree. Contact the program director to determine which, if any, graduate certificate credits may apply. Graduate admissions procedures must be followed.

**Prerequisite Courses (if required)**

- CS 500 Introduction to Structured Programming
- CS 501 Introduction to Data Structures

**Required Courses**

- CS 553 Java Scripting for Web Design
- CS 554 Fundamentals of Interactive Multimedia

**Elective Courses**

(Choose two; other electives may also be available after consultation with the program director)

- CS 550 Dynamic Web Page Development
- CS 552 Windows Interface Design (VB.net)
- CS 561 Multimedia Authoring (Authorware)
- CS 563 Flash Animation

Certificate total: 12–18 credits

**WEB DEVELOPMENT CERTIFICATE**

This program provides students with the background and technical skills needed for a comprehensive understanding of the development, design and construction of professional web pages.

**Requirements**

The program requires the student to complete a minimum of 12 semester credit hours of coursework with a minimum cumulative GPA of 3.0. Two program prerequisites apply to those without suitable academic credentials in programming. Some required courses also require additional prerequisites (e.g., CS 501) All course credits earned in the program may be applied to the master’s program.

**Prerequisite Courses (if required)**

- CS 500 Introduction to Structured Programming
- CS 501 Introduction to Data Structures

**Required Courses**

- CS 550 Dynamic Web Page Development
- CS 552 Windows Interface Design (VB.net)
- CS 553 Java Scripting for Web Design
- CS 557 Web Programming with ASP.net

Certificate total: 12–18 credits

**CYBER-SECURITY CERTIFICATE**

The Graduate Certificate Program in Cyber-Security is designed to provide individuals with an introduction to information security, risk and threat management, security architecture, and skills to effectively address the constantly changing threat landscape faced by people, companies, and governments today. The courses in the certificate program will:

- Provide a broad knowledge of networking and network security.
- Provide an overview of proper technology risk management practices.
- Help the individual be able to identify new and existing threats and determining methods to mitigate them.
- Provide the individual the skills to handle security incidents.
- Provide the individual with an introduction to building secure and defendable systems.

**Certificate Requirements**

The program requires the student to complete a minimum of twelve (12) semester credit hours of course work with a minimum cumulative GPA of 3.0. There are two
prerequisites to the certificate: CS 621 and CS 622 (see below).

**Prerequisite Courses (if required - 3 credits each)**
- CS 621 Principles of Data Communication
- CS 622 Network Security I

**Required Courses (3 credits each)**
- CS 626 Cyber-Security
- CS 627 System Security
- CS 628 Security Management

**Elective Courses (choose one of the following - 3 credits each)**
- CS 629 Ethical Hacking
- CS 641 Securing the Cloud
- CS 642 Securing the Client/Server

**IT AND NETWORK SECURITY CERTIFICATE**
Our country and, in fact, the entire world have become increasingly dependent on information technology as a means of staying competitive in business, industry, the arts, and commerce of all types. Education, electronic commerce, and the Defense Department are all areas that utilize technology on an exponentially expanding level with each passing year. But this dependence on and utilization of technology are accompanied by a growing risk of security issues that must be addressed if we are to thrive and survive in a technology-driven world. Inadequate security practices have left corporations vulnerable to a number of illegal activities such as computer fraud, telecommunications abuse, and unauthorized disclosure, modification, and destruction of information. National security has been and will continue to be threatened unless corporations and the government on all levels are able to effect and maintain sufficient computer security.

The certificate program in IT and Network Security is designed to provide individuals with introductory networking, ethical, and security skills to effectively address the areas of concern mentioned above. The courses in the certificate program:

- provide an overview of networking protocols and how they can be secured;
- introduce the individual to an array of social and ethical issues that are incumbent on those in providing security; and
- provide the individual with an introduction to computer programming, as it relates to the maintenance of security protocols.

Upon completion of the certificate program, the student will be better equipped to enter or continue as a professional in the cyber security field.

**Requirements**
The certificate requires a total of 12 credits plus two prerequisite courses (CS 500 and CS 501). Prerequisite courses may be waived if evidence of prior completion of these prerequisites can be supplied. Courses taken for the certificate can be applied toward the MSCIS degree.

**Prerequisite Courses (if required)**
- CS 500 Introduction to Structured Programming
- CS 501 Introduction to Data Structures

**Required Courses**
- CS 621 Principles of Data Communication
- CS 622 Network Security I
- CS 623 Advanced Network Security

**Elective Courses**
- CS 624 Hands-On Network Security
- CS 625 Cryptography
DATABASE DESIGN CERTIFICATE

Prerequisites

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
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</thead>
<tbody>
<tr>
<td>CS 500</td>
<td>Introduction to Structured Programming</td>
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<tr>
<td>CS 501</td>
<td>Introduction to Data Structures</td>
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</table>

Required Courses

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
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<tbody>
<tr>
<td>CS 603</td>
<td>Database Design (Oracle)</td>
</tr>
<tr>
<td>CS 631</td>
<td>Data Warehousing</td>
</tr>
<tr>
<td>CS 632</td>
<td>Advanced Database Topics</td>
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<tr>
<td>CS 633</td>
<td>Advanced Database Programming</td>
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(CS 603 will be a prerequisite for CS 631, CS 632 and CS 633)

Course Descriptions

**CS 500 Introduction to Structured Programming**
3 CH
This is an introductory course in computer programming using a structured programming language. Representative topics include: iteration, selection, procedures, functions, arrays and classes.

**CS 501 Introduction to Data Structures**
3 CH
Prerequisite: CS 111 or CS 500 Introduction to Structured Programming or equivalent.
A continuation of CS 500 utilizing a structured programming language and classes to further implement multidimensional arrays and other data structures including: linked lists, stacks, queues, trees, etc. Also provides introduction to recursion and data abstraction.

**CS 502 C: Advanced Programming**
3 CH
Prerequisite: CS 112 Data Structures or equivalent, or CS 501 Introduction to Data Structures.
Discusses advanced programming techniques with an emphasis on mathematical and scientific programming applications. Topics include: recursion, pointers and some advanced data structures. C language is introduced in this course.

**CS 504 Introduction to Programming Using Scripting**
3 CH
This course will provide an introduction to structured programming and elementary data structures using the Javascript language [or any other scripting or dynamic language such as Python, Perl, PHP, LUA or Ruby].
Topics covered include basic programming concepts, control statements, loops and branching structures, string processing, and debugging.

**CS 505 Computer Networks**
3 CH
Prerequisite: CS 504 Introduction to Programming Using Scripting or permission of Department.
Students in this course will study networks and data communication concentrating on the Internet model. This is a laboratory-based course that includes projects implemented on both Unix and Windows machines using Wireshark. Students will review Hex and Binary number systems. Topics such as network architecture, the Internet Protocol Stack, LANs, WANs and MANs; hardware, software, protocols, routing, circuit-switching and packet-switching networks, wireless networks, compression and error handling are studied.

**CS 550 Dynamic Web Page Development**
3 CH
Prerequisite: CS 500 Introduction to Structured Programming.
This course enables students to develop low-bandwidth visual effects for web pages. A variety of software is employed to develop web sites and media for the
web. Topics include: web animation and interactivity using Adobe Flash®, a vector-based animation tool; vector-based graphic construction and digital compression using Macromedia Fireworks®, a graphic optimizing tool; and dynamic web page construction using Adobe Dreamweaver®, a visual HTML editor.

**CS 551 Introduction to Object-Oriented Programming with Java**  
3 CH  
Prerequisite: CS 501 Introduction to Data Structures.  
Provides an introduction to the fundamental concepts of object-oriented analysis (OOA), design (OOD) and programming (OOP), and how object-oriented languages differ from procedural languages. Notation is used to teach the concepts of abstraction, encapsulation, modularity, hierarchy and polymorphism. This course is designed for both programmers and analysts. Both C++ and Java are used to implement these object-oriented concepts.

**CS 552 Windows Interface Design (VB.NET)**  
3 CH  
Prerequisite: CS 501 Introduction to Data Structures.  
This course introduces the fundamentals of writing Windows applications, event-driven programming and the GUI. Topics include: dialogues, menus, controls, data types, scope and life of variables, objects and instances, fonts and graphics, simple file I/O and other DLL procedures. VB.net is used in implementing various Windows applications.

**CS 553 Web Design with Java Script**  
3 CH  
Prerequisite: CS 500 Introduction to Structured Programming.  
This course shows how to embed Java “applets” into HTML pages, as well as create applets. The course covers the Java applet paradigm and the standard Java-class libraries. Students write Java applets, standalone applications, Native Libraries and content/protocol handlers for extending web browsers.

**CS 554 Fundamentals of Interactive Multimedia**  
3 CH  
Prerequisite: CS 500 Introduction to Structured Programming.  
Students develop multimedia applications of their own design using Adobe Director®. This course explores principles for effective interactive multimedia design from concept definition, storyboarding, multimedia development and authoring to testing and revision. It covers techniques to include sound, graphics, photographs, animation, video and text into multimedia presentations. Adobe Director movies are developed for use in authoring applications such as business presentations, interactive kiosks, CD-ROMs and Shockwave movies for the web.

**CS 555 Advanced Scripting with Interactive Multimedia**  
3 CH  
Prerequisites: CS 501 Introduction to Data Structures and CS 554 Fundamentals of Interactive Multimedia.  
This advanced multimedia development course explores program control for effective design and delivery of interactive multimedia applications. Students learn how to use the director’s full-feature scripting language Lingo to develop the interactivity and program control of multimedia projects. Xobjects, special code segments that control external devices, are also covered.

**CS 557 Web Programming with ASP.net**  
3 CH  
Prerequisite: CS 552 Windows Interface Design (VB.net) and CS 603 Database Design (Oracle)  
Covers Active Server Pages and how they allow for powerful web site creation by combining program code with standard HTML. The class is presented in a tutorial
system application. Students will successfully learn how to program using Visual Basic Script, the most commonly used ASP programming language. Other relevant topics include: integrating databases with a web site and effective site functionality.

**CS 558 Advanced Topics in ASP.net**

3 CH  
Prerequisite: CS 557 Web Programming with ASP.net  
The class will focus on some advanced ASP.NET topics such as AJAX, web services, building custom components, profiles, LINQ, and web parts.

**CS 559 C#**

3 CH  
Prerequisite: CS 552 Windows Interface Design (VB.net)  
Introduces the .NET platform using C# which is a modern object-oriented language to build interfaces with applications for both windows and the web. OLE Automation, and Database (ADO.net) development will be introduced.

**CS 560 Networking Applications**

3 CH  
Prerequisite: CS 621 Principles of Data Communication  
This hands-on course provides an in-depth introduction to IP addressing, TCP/IP, routing of IP packets, Internet protocol, TCP, DHCP, DNS, network management and a brief introduction to network security including use of firewalls, proxy servers, and footprint analysis.

**CS 561 Multimedia Authoring (Authorware)**

3 CH  
Prerequisite: CS 500 Introduction to Structured Programming  
This authoring course covers design and delivery of interactive multimedia using an icon-based product. Students use the authoring tool Authorware to develop a variety of projects: CBT, interactive kiosks, performance support applications, interactive magazines and catalogs, educational games and interactive education and information that can be delivered over intranets.

**CS 563 Flash Animation**  
3 CH  
This is an introduction to Flash Animation class. Students will discover how to produce interactive multimedia. The course covers the Flash interface and tools used to develop Flash animations such as shape and motion tweening, motion guide path, masking, development of scenes, creation of movie clips and button symbols. They are used to create a variety of animations such as: interactive presentations, interactive greeting cards, interactive tutorials, Web Sites, puzzles and small games. Basic ActionScript will be covered in this class.

**CS 564 Action Scripting**  
3 CH  
Prerequisite: CS 563 or perm of dept  
The course provides the knowledge to use and write functions in ActionScript, understand the basics of event driven programming, interact with onscreen objects, use iteration to create objects and define custom classes and utilize the language’s built-in classes.

**CS 571 Advanced Computer Gaming**  
3 CH  
Prerequisite: CS 501 Introduction to Data Structures  
An object-oriented approach to programming digital objects using Flash and Action Script 3.0. These programming techniques will be applied to both arcade and adventure games.
**CS 572 OOP with C# and Games**
3 CH
Prerequisite: CS 571 Advanced Computer Gaming
An object-oriented approach to computer graphics using C#. Topics covered will include: classes, instantiation, event listeners, polymorphism, encapsulation, event handlers, functions and methods, and basic game logic.

**CS 573 Advanced Game Programming**
3 CH
Prerequisite: CS 572 OOP with C# and Games
A game oriented programming course focusing on advanced graphics techniques using OpenGL and/or DirectX.

**CS 583 Theory of Computer Gaming**
3 CH
Computer Game Studies is an emerging field. This course provides a solid, theoretical background in the field of computer gaming which will assist them in their pursuit of game development throughout their career.

**CS 601 Assembly Language Programming and Computer Systems**
3 CH
Prerequisite: CS 501 Introduction to Data Structures.
Explores programming concepts at the interface of hardware and software: addressing, instructions, symbol tables, linkage, registers, ALU and CPU, anatomy of an assembler, relocatable code, macros, interrupts and debuggers.

**CS 602 Advanced Data Structures and Algorithms**
3 CH
Prerequisites: MA 151 Calculus I, CS 502 C: Advanced Programming and CS 241 Advanced Programming Concepts Using “C.”
Explores the relationship between data structures and algorithms with a focus on space and time efficiency: review of recursion, data abstraction and complexity analysis, multilists, trees (including balanced binary trees, n-ary trees and Btrees), hash tables, external sorting, graphs and algorithm design techniques.

**CS 603 Database Design (Oracle)**
3 CH
Prerequisite: CS 501 Introduction to Data Structures.
Discusses goals and techniques in the design, implementation and maintenance of large database management systems: physical and logical organization; file structures; indexing; entity relationship models; hierarchical, network and relational models; normalization; query languages; and database logic.

**CS 604 Advanced Software Engineering**
3 CH
Prerequisite: CS 551 Introduction to Object-Oriented Programming with Java or permission of Department.
Advanced Programming. Reviews models and metrics for software engineering in the large: software life-cycle models, software modeling tools, design and analysis of software subsystems, management of software projects, test plans, configuration control, reliability and metrics.

**CS 605 Discrete Structures and Logic**
3 CH
Prerequisites: CS 501 Introduction to Structured Programming and MA 151 Calculus I.
Reviews the mathematical concepts and foundations of logic for computer science: sets, relations and functions; Boolean algebras; graphs; propositional and predicate logic; notions of logical consequence and provability; soundness and completeness of inference methods; resolution; unification; and introduction to theorem proving.
CS 611 Operating/Multiprogramming Systems  
3 CH  
Prerequisite: CS 502 C: Advanced Programming.  
Explores the management of resources in a multiuser system: memory allocation and management, process scheduling, protection, concepts of concurrent processes, study of different operating systems and multiprocessing.

CS 613 Structure of Programming Languages  
3 CH  
Prerequisite: CS 602 Advanced Data Structures and Algorithms.  
Discusses the syntax and semantics of programming languages including: an introduction to theory of languages and grammars; concepts of design and implementation of programming languages; and the comparison of different language paradigms such as imperative, functional, logic and object-oriented.

CS 614 Theory of Computation  
3 CH  
Prerequisite: Permission of instructor.  
Reviews the theory of the power and limitations of computation and computers: Turing machines, recursive and recursively enumerable functions, equivalence of computing paradigms (Church Turing thesis), undecidability, intractability and introduction to NP-completeness.

CS 615 Programming in Unix  
3 CH  
Prerequisite: CS 611 Operating/Multiprogramming Systems or permission of instructor.  
Discusses main issues of Unix OS programming and administration. In particular, it explores a popular Unix text editor Emacs, Unix file system, process manipulation, regular expressions and their use, filters, and system administration and security.

CS 620 Information Analysis and System Design  
3 CH  
Prerequisite: CS 501 Introduction to Data Structures.  
Discusses the design, analysis and management of information systems: system lifecycle management, hardware and software selection and evaluation, the role of information systems in decision support and other functional areas of business, project management, systems development and analysis, module design and techniques to reduce system complexity.

CS 621 Principles of Data Communication  
3 CH  
Prerequisite: CS 501 Introduction to Data Structures.  
A survey of modern data communication techniques, including: data communication and local networking, hardware (e.g., terminals, modems, multiplexors), nodal and host processor architecture, packet switching, network control, protocols, software management and security.

CS 622 Network Security I  
3 CH  
Prerequisite: CS 621 Principles of Data Communication.  
Is there a security problem in computing? How do IT and network managers interface with business managers to create a security system that meets the needs of both sides of the business? How does network security support the business mission and how many resources is business willing to give to support network security? This course addresses these complex issues. Among the topics covered are: conventional encryption and message confidentiality, public key cryptography and message authentication, authentication applications, e-mail security, IP security, Web security, firewalls, security in mobile networks, and other security issues.
**CS 623 Advanced Network Security**  
3 CH  
Prerequisite: CS 622 Network Security I.  
This is the second course in security that emphasizes security at the system level. The course covers secure encryption, systems, program security (viruses and other malicious code), controls against program threats, protection in general purpose operating systems, trusted operating systems, database security, security in networks and distributed systems, administering security, and legal and ethical issues in security.

The course includes implementation of various encryption algorithms in different programming systems.

**CS 624 Hands-On Network Security**  
3 CH  
Prerequisites: CS 621 Principles of Data Communication and CS 622 Network Security I.  
Designed for IT graduate students, this course uses VMWare of Connectix Virtual PC to simulate different environments. It examines networking security topics, firewalls (using Linux), packet filters, NAT, PAT, socks and HTTP proxies; public key infrastructure (using Microsoft Certification Server), encryption algorithms, decrypting passwords, dictionary decryption, brute force decryption, certificate servers; and vulnerability assessment, identifying security holes, forensics, tracing, log analysis, Layer 5 vulnerabilities (Services/Daemons and OS), identifying denial of service attack (simulation), identifying a virus/work attack (simulation), packet monitoring (sniffing).

**CS 625 Cryptography**  
3 CH  
Prerequisite: CS 622 Network Security I or permission of instructor.  
Designed for CS graduate students, the course covers theoretical and practical aspects of modern applied computer cryptography. Topics include: block and stream ciphers; hash functions, data authentication, and identification; and digital signatures. Special emphasis is given to public-key cryptosystems.

**CS 626 Cyber-Security**  
3 CH  
Prerequisite: CS 622 Network Security I.  
What is Cyber-Security? What is a threat and how do you protect against the constantly changing cyberworld? Securing an organization’s cyber environment is everyone’s responsibility. This course will cover the following topics:

- Introduce Cyber-Security Concepts
- Cyber-Security Threats
- Cyber-Security Attack Types
- Cyber-Security Attack History
- Approaches to securing the organization
- Protections from Cyber-Security Threats
- Other security issues

**CS 627 System Security**  
3 CH  
Prerequisite: CS 626 Cyber-Security.  
How do you secure the critical infrastructure that supports our cyber-security landscape? What threats and attacks do systems constantly face? This course will address these complex issues in securing the system & applications that run in today’s organizations. Among the topics covered are:

- Secure System Hardening
- Access Controls
- Security System Management
- Secure Administration
- Security Monitoring
- Secure Back-ups
- Application Security Concepts
- Other security issues
CS 628 Security Management
3 CH
Prerequisite: CS 626 Cyber-Security.
All of the new security technologies require good management to maintain effectiveness. With so many new technologies, how do we make the security technology effective? Where do we start? How do we measure and plan to improve a company's security posture? This course will address these complex issues about managing security within an organization. Among the topics covered are:

- Policy & Information Security Program Development
- Incident Response
- Identity Access Management
- Security Governance
- Security Risk Management
- Vulnerability Management
- Security Metrics

CS 629 Ethical Hacking
3 CH
Prerequisite: CS 622 Network Security I.
This course introduces students to the security threat of computer hacking and system vulnerabilities & exploits. The course will introduce techniques and hacking skills that blackhat hackers use to compromise systems. The class will teach students how to perform whitehat hacking and ethical hacking techniques to safeguard a computer network.

CS 631 Data Warehousing
3 CH
Prerequisite: CS 603 Database Design (Oracle)
Provides a comprehensive review of data warehousing technology. Areas of study include the evolution of the modern-day data warehouse; analysis and collection of business data requirements; dimensional modeling; the loading of data using Extraction, Transformation, and Loading (ETL) processes; data quality issues; and reporting from the data warehouse using SQL and Online Analytical Processing (OLAP) techniques. Several Oracle lab experiments are conducted to provide hands-on experience in the areas of data warehouse design, construction, data loading, and essential reporting techniques.

CS 632 Advanced Database Topics
3 CH
Prerequisite: CS 603 Database Design (Oracle).
Provides students with an advanced understanding of database technology. In addition to the entity relationship model, alternate database models (such as EAV and OOD) are investigated. Possible topics include indexing, optimization, XML, online analytic processing (OLAP), embedded SQL, locking techniques and parallel and distributed systems. Specific topics covered and focus of this course changes to reflect modern trends and the latest technology.

CS 633 Advanced Database Programming
3 CH
Prerequisite: CS 603 Database Design (Oracle).
Provides students with a thorough understanding of database programming. Students use the latest technology to create front-end applications to hit large-scale backend databases. SQL and stored procedures are used to retrieve data from various data stores. Emphasis is placed on a layered approach to programming. User-friendly design principles and business logic are used to teach students how to implement large-scale windows and/or web applications. The specific technology used will vary to reflect current trends in database programming technology.
**CS 635 Digital Forensics**

3 CH

Prerequisite: CS 505 Computer Networks or permission of department.

In this course, students will learn how to: understand and differentiate between file systems and operating systems; explain in detail the FAT file system; be exposed to the NTFS file system; identify Windows artifacts and registry artifacts; understand hashing and its uses in digital forensics; understand 4th amendment considerations when searching and seizing digital evidence (per CT law) chain of custody; use hardware write blockers, varieties and uses; perform data acquisitions using methods and tools discussed in class; perform basic data recovery; understand file signatures and its uses; risk assessment.

**CS 636 Secure Programming Techniques in Java/.NET/JavaScript/SQL**

3 CH

Prerequisite: CS 501 Introduction to Data Structures or CS 504 Introduction to Programming Using Scripting.

It all starts with programmers: every computer system today runs some type of software in its core and as a result is ground zero for all security concerns. Using Microsoft’s proven Secure Development Lifecycle as a model, this course will provide an introduction on how to setup a secure development environment, go over best practice models and secure programming techniques in Java or .NET frameworks, as well as common web application languages such as client side JavaScript and SQL database programming.

**CS 637 Professional Responsibility: Cyber Security: Policies and Practice**

3 CH

This course will examine the issues associated with cyber-security from business, technical and ethical perspectives. What does it mean to be a cyber-security professional? Topics include but are not limited to: network neutrality, corporate and government policies, digital divide, child pornography, intellectual property, hacking and phishing, malware as big business, treaties and their limits. The course will also examine recent bills being considered by the U.S. government as well as the EU and other countries. Examples taken from the real world such as how to handle the cyber-security of installed medical devices, insulin pumps, pacemakers, and the tradeoffs between providing external access for EMTs and keeping out hackers will be explored.

**CS 638 Concepts in Dynamic and Script Programming**

3 CH

Prerequisite: CS 501 Introduction to Data Structures or CS 504 Introduction to Programming Using Scripting.

This course will provide an introduction to dynamic programming and scripting languages using [any dynamic language that can also be used for scripting such as Python, Perl, PHP, TCL, or LUA]. Topics covered include flow processing, regular expressions, binding, object oriented concepts, shell scripting, frameworks and design libraries, script debugging, and exception handling.

**CS 639 Vulnerability Management**

3 CH

Prerequisite: CS 505 Computer Network or permission of Department.

This course will provide lectures on vulnerability & compliance management for multiple systems & perform hands-on experience with Tenable Nessus (one of the industry leading vulnerability and compliance scanning tools). It will provide students with a working knowledge and understanding of vulnerability & compliance management. With many new system & application vulnerabilities that get identified on a daily basis, and how to manage them. The purpose of this course is to teach students how to identify vulnerabilities, plan to remediate them, and track to make sure that they do not return.
CS 640 Special Topics in Computer Science
3 CH
Prerequisite: Determined at the time of course offering.

Presents one-time and first-time offerings of courses on current topics.

CS 641 Securing the Cloud
3 CH
Prerequisite: CS 627 System Security.

Cloud computing is rapidly becoming a popular choice for hosting everything from entire operating systems, and software, to service (SaaS) applications such as websites, databases, email, data backup, and so forth. The course will provide an introduction to cloud technologies and their best practices. Learn the unique challenges posed by this type of platform and how to properly configure and secure cloud based assets.

CS 642 Securing the Client/Server
3 CH
Prerequisite: CS 626 Cyber-Security.

Clients and servers run Operating System (OS) software as well as many applications with each presenting a unique concern from a security perspective. Get an in-depth look at how to properly harden today’s most popular Operating Systems: Microsoft Windows, Apple OS X, and Linux. This course covers built-in security features of each OS and how best to utilize these and other third party applications to setup a secure system. The course will also introduce how to secure services and applications provided with these OSes such as Sendmail and MS Exchange, MySQL and MS SQL Server, Apache and MS IIS.

CS 646 Computer Graphics
3 CH
Prerequisite: CS 602 Advanced Data Structures and Algorithms.

Reviews the principles of design and use of computer graphics: matrix algebra overview, basic drawing techniques, line and polygon clipping, linear transformations, projections, graphics standards and hardware, raster scan, refresh, storage, hidden line and surface elimination and shading.

CS 648 Distributed Database Systems
3 CH
Prerequisites: CS 603 Database Design (Oracle) and CS 611 Operating/Multiprogramming Systems.

Explores the problems and opportunities inherent to distributed databases: file allocation, deadlock detection and prevention, synchronization, update consistency, query optimization, fault tolerance, etc.

CS 650 Principles of Natural Language Processing
3 CH
Prerequisite: CS 613 Structure of Programming Languages or CS 642 Securing the Client/Server.

Studies the issues arising in computer processing of languages like English and solution techniques: AI principles overview, significance of language structure in extracting meaning, ambiguities, parsing techniques, semantic issues, semantic models, pragmatics, text-based systems and case studies.

CS 652 Neural Networks
3 CH
Prerequisites: MA 151 Calculus I and CS 642 Securing the Client/Server.

Discusses neural networks as a computation model complementary to symbolic AI: basic principles, history of neurocomputing, various models and their common ideas, applications in machine learning and pattern recognition and hybrid systems.
CS 654 Object-Oriented Programming Using C++  
3 CH  
Prerequisite: CS 502 C: Advanced Programming or equivalent.  
Reviews the principles of OOP: encapsulation, polymorphism and inheritance. C++ is used as the main vehicle for getting the ideas across. Issues of multiple inheritance, persistence, etc. are covered, and comparison with other OOP languages are made, as time permits.

CS 663 Game Design for Mobile Devices  
3 CH  
Prerequisite: CS 662 Game Design, Development, and Implementation.  
In this course students explore the complex process required to design and build content and games for mobile devices. Students will learn how to structure and optimize code as well as employ user interface controls. Memory-awareness, limited performance, security, and limited resources will be covered.

CS 661 Game Design and Development Using 3-D  
3 CH  
Prerequisite: CS 573 Advanced Game Programming.  
The course will cover Open GL and/or some advanced tools of DirectX or other appropriate software which will facilitate the integration of 3-D action and movement in a game designed for the course. The students will work in teams (if appropriate) to complete a 3-D game during the course.

CS 662 Game Design, Development, and Implementation  
3 CH  
Prerequisite: CS 573 Advanced Game Programming.  
In this course students work as a team to develop an innovative, original computer game. Group responsibilities include project planning and documentation, teamwork, presentations and demonstrations. Students learn the technical skills involved in game architecture, including advanced character animation and nesting, game physics, sound syncing and editing, lighting simulation techniques, and game balance. Special attention will be paid to emerging game development opportunities in education, professional training, medicine, advertising and scientific research.

CS 664 Advanced Topics in Multiplayer Gaming  
3 CH  
Prerequisites: CS 661 Game Design and Development Using 3-D and CS 662 Game Design, Development, and Implementation.  
The course considers the technical, programming and creative aspects for developing an effective multi-player game. Topics covered include: virtual machines, connection techniques, live player chat, authoritative client and authoritative server choices, latency and clock simulation, lobby systems, real time competitive games, cooperative game play avatars, virtual worlds and user homes.

CS 670 Research Project Seminar  
3 CH  
Prerequisite: Determined by the faculty advisor.  
Required for the non-thesis option, the student works with a faculty advisor in defining a short research or implementation project. For a research project, the student surveys relevant literature, critically analyzes the state of the art and possibly synthesizes improvements. For an implementation project, the student implements and tests a solution to the chosen problem; the project could involve a combination of research and implementation. At the end of the project, the student writes a report approved by the faculty member and makes a public presentation of the work.
CS 690 Thesis I

3 CH

Prerequisite: Determined by the faculty advisor.

Required for the thesis option, the student works with a faculty advisor in defining a substantial research or implementation project. For a research project, the student surveys relevant literature, critically analyzes the state of the art and synthesizes improvements. For an implementation project, the student implements and tests a solution to the chosen problem, comparing it with other work, if any; the project could involve a combination of research and implementation. At the end of this course, the student should have a well-defined problem, have surveyed relevant literature and have made partial progress toward the completion of the work. The student should be ready to make a brief presentation of the work in progress, as required by the advisor. Also, by the end of this course, a proposal describing the work should be written and approved by a thesis committee chosen by the student and the advisor, according to University policy.

CS 691 Thesis II

3 CH

Prerequisite: CS 690 Thesis I.

A continuation of CS 690, this course is required for the thesis option. By the end of this course, the student completes the work remaining in the project started in CS 690, as defined by the written proposal. A thesis must be written and defended in front of the thesis committee. The presentation portion of the thesis defense is open to the public.