Master of Science in Computer Science
Graduate Arts and Sciences

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M.S. Computer Science Goals and Objectives

Overview
The Department of Computer Science at Saint Joseph’s University offers the following degrees: B.S. Computer Science, B.S. Information Technology, and M.S. Computer Science. The department has recently earned ABET (Accreditation Board For Engineering And Technology) accreditation of its B.S. in Computer Science program.

Learning Goal 1: Graduates succeed as practicing computer scientists.

Students will be able to:
Objective 1.1: Solve problems and implement their solutions in an appropriate computational environment.

Objective 1.2: Apply their knowledge of computer science, mathematics, and science to solve technical problems.

Objective 1.3: Design systems, components, or processes to meet specified requirements.

Objective 1.4: Work in teams to create various software systems, both large and small.

Objective 1.5: Communicate effectively, orally and in written form, individually and/or in teams.

Learning Goal 2: Graduates adapt and evolve in complex technological environments such as those found in the workplace.

Students will be able to:
Objective 2.1: Solve problems and implement their solutions in an appropriate computational environment.

Objective 2.2: Apply their knowledge of computer science, mathematics, and science to solve technical problems.

Objective 2.3: Design systems, components, or processes to meet specified requirements.

Objective 2.4: Work in teams to create various software systems, both large and small.

Objective 2.5: Analyze contemporary issues related to the evolving discipline of computer science.

Objective 2.6: Communicate effectively, orally and in written form, individually and/or in teams.

Learning Goal 3: Graduates are careful, precise, mature thinkers, and take with them the intellectual preparation they need to apply what they have learned, communicate it to others, and continue their education for the rest of their lives. Students will be able to:

Objective 3.1: Enter and successfully complete Ph.D. programs in computing.

Objective 3.2: Solve problems and implement their solutions in an appropriate computational environment.

Objective 3.3: Apply their knowledge of computer science, mathematics, and science to solve technical problems.

Objective 3.4: Design systems, components, or processes to meet specified requirements.

Objective 3.5: Articulate the social, professional, ethical and legal aspects of a computing environment.

Objective 3.6: Analyze contemporary issues related to the evolving discipline of computer science.

Objective 3.7: Communicate effectively, orally and in written form, individually and/or in teams.

Admission Requirements and Procedures
Application to the program does not require a GRE test, as assessment is based on examining the applicants’ transcripts. There is also no minimum GPA required. Applicants should have the following undergraduate preparation*:

Computer Science
The equivalent of the following courses currently required in the undergraduate Computer Science program:
CSC 120        Computer Science I
These courses use the Java programming language.

Mathematics

The equivalent of the following courses in an undergraduate Mathematics or Computer Science program.

MAT 226 Linear Algebra
CSC 240 Discrete Structures

*New students will be required to take a placement examination in these subjects. Students who are deficient in these requirements must take and earn (without graduate credit) a grade of B in the appropriate courses.

Application Procedures

Applicants should submit or have sent to the Office of Graduate Operations the following:

- a completed Saint Joseph's University graduate application.
- official sealed transcript(s) of undergraduate/graduate coursework. If you are a SJU graduate the Office of Graduate Operations will obtain your SJU transcripts for you.
- two letters of recommendation appraising the candidate’s promise and capacity for graduate study, reflecting, from a professional’s point of view, the candidate’s ability to pursue a rigorous, independent course of study at the graduate level.
- a personal statement outlining the candidate’s professional goals and educational objectives for the program, including the applicant’s rationale for program choice and professional study.
- $35 application fee – waived if attended an Open House or an SJU graduate.

Program Options

Students may choose to graduate with an:

- M.S. degree in computer science: General Option, or
- M.S. degree in computer science: Concentration Option

Degree Requirements for M.S. in Computer Science: General Option

A total of ten (six core and four elective) courses is the minimum required for the M.S. in Computer Science with General Option. Of these, a maximum of two courses may be for an approved research project

Requirements for Six Core Courses:

Students take the following six core courses:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
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<tbody>
<tr>
<td>CSC 550</td>
<td>Object Oriented Design and Data Structures</td>
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<tr>
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<td>Design and Analysis of Algorithms</td>
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<tr>
<td>CSC 552</td>
<td>Computer Architecture</td>
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<tr>
<td>CSC 553</td>
<td>Computer Systems</td>
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<tr>
<td>CSC 554</td>
<td>Theory of Computation</td>
</tr>
<tr>
<td>CSC 610</td>
<td>Software Engineering</td>
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</tbody>
</table>

A student who receives a grade lower than a B in a core course must retake the course.

Requirements for Four Elective Courses:

Students take any four CSC courses numbered 600 and above.

Degree Requirements for M.S. in Computer Science: Concentration Option

A total of ten (four core and six elective) courses is the minimum for obtaining an M.S. degree in Computer Science in any of the following concentrations:

- Web and Database Technologies
- Information Sciences

Requirements for Four Core Courses: Students who do not need prerequisite courses take the following two required core courses during their first and second semesters, respectively:

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<td>CSC 551</td>
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</tbody>
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The two elective core courses are taken from the following list:

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<tr>
<td>CSC 621</td>
<td>Database Systems</td>
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<td>CSC 627</td>
<td>Introduction to Security</td>
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<td>CSC 680</td>
<td>Artificial Intelligence</td>
</tr>
<tr>
<td>CSC 681</td>
<td>Programming Paradigms</td>
</tr>
</tbody>
</table>

A student who receives a grade lower than a B in any core course must retake the course.

Requirements for Six Elective (Concentration) Courses:

Students take four courses from the same concentration plus any other two CSC courses
numbered 600 and above to receive a specialized M.S. degree from that concentration:

**Web and Database Technologies Concentration**
- CSC 620  Internet Application Development
- CSC 621  Database Systems
- CSC 622  Advanced Database Concepts
- CSC 623  Data Communications and Networking
- CSC 626  Web Technologies
- CSC 627  Introduction to Security
- CSC 628  Advanced Security

**Information Sciences Concentration**
- ACC 550  Creating and Measuring Shareholder Value
- MGT 551  Empowering Human Potential at Work
- DSS 600  Foundations for Business Intelligence
- DSS 610  Business Analytics for BI

*Other business courses chosen in consultation with the Graduate Computer Science Director may be acceptable as well. Students whose business background is deficient may be required to take one or both of the following, in addition to any mathematics or computer science prerequisite courses required: ACC 500 Accounting, Business Analysis, and Financial Reporting, MGT 500 Managing Work Organizations.

**Foundation Courses**

**CSC 500 Discrete Structures (3 credits)**
Mathematics needed for Computer Science. Topics covered include: functions, relations, propositional and first order predicate logic, set theory, proofs and their construction, counting and elementary probability. The course will use a declarative language as a tool to support concrete implementations of the mathematical ideas.

**CSC 501/502 Computer Science I and II 3/3 credits**
This is an intensive, one-semester, two-course sequence intended to provide students with the necessary background in programming for the graduate program. The use of the computer to solve problems. Students will learn general principles of program design, at first by using libraries of predefined program units, and later, by constructing complete programs. Emphasis is on developing techniques for program design that lead to correct, readable and maintainable programs. Intermediate programming techniques including the use of recursion. An introduction to encapsulated data structures. Lists and list sorting will be used to introduce a discussion of algorithm efficiency.

**Core Courses**

**CSC 550 Object Oriented Design and Data Structures (3 credits)**
The course combines a strong emphasis on Object-Oriented Design principles and design patterns with the study of data structures. Fundamental Abstract Data Types, their implementations and techniques for analyzing their efficiency will be covered. Students will design, build, test, debug and analyze medium-size software systems and learn to use relevant tools.

*Prerequisite: CSC 502 Computer Science II or permission of the Graduate Director. Co-requisite: CSC 500 Discrete Structures.*

**CSC 551 Design and Analysis of Algorithms (3 credits)**
Concepts of program complexity; basic approaches to complexity reduction: data structures and techniques; worst cases and expected complexity. Topics to be covered may include sorting, set manipulation, graph algorithms, matrix multiplication, and finite Fourier transforms, polynomial arithmetic, and pattern matching.

*Prerequisite: CSC 550 Object Oriented Design and Data Structures.*

**CSC 552 Computer Architecture (3 credits)**
Overview of computer system organization, hardware components, and communications. Introduction to Boolean algebra, combinational and sequential logic, arithmetic, the CPU, memory, microprocessors, and interfaces. CISC vs. RISC processors. Practical assembly language programming will be the emphasis with an introduction to micro architecture and microprogramming on a variety of processors.

**CSC 553 Computer Systems (3 credits)**
An overview of the software required to integrate computer hardware into a functional system. The following topics are covered. Operating systems as resource managers and as virtual machines. System calls, in particular those required for process and file management; interrupt driven systems; concurrency; memory management; file systems and security.

*Prerequisite: CSC 550 Object Oriented Design and Data Structures or permission of the Graduate Director.*

**CSC 554 Theory of Computation (3 credits)**
Formal languages, formal grammars, abstract machines; models of computation (e.g. Turing machines); computational complexity (NP completeness); undecidability and uncomputability.

Prerequisite: CSC 500 Discrete Structures.

CSC 610 Software Engineering (3 credits)
(See description in Software Engineering Courses)

CSC 621 Database Systems (3 credits)
(See description in Web and Database Technologies Courses)

CSC 680 Artificial Intelligence (3 credits)
(See description in Free Distribution Courses)

CSC 681 Programming Paradigms (3 credits)
(See description in Free Distribution Courses)

Software Engineering Courses

CSC 610 Software Engineering (3 credits)
The purpose of this class is to teach the process of developing software. It combines a study of methods, tools, and techniques for creating and evolving software products, with the practical skills needed to deliver high-quality software products on schedule. The methods that are studied include requirements, specification, design, implementation, testing, and maintenance. The course includes a substantial group project. Prerequisite: CSC 550 Object Oriented Design and Data Structures.

CSC 611 Human Computer Interaction (3 credits)
User models: conceptual, semantic and syntactic considerations; cognitive and social issues for computer systems; evaluating HCI; direct manipulation; the model view controller architecture; widgets and toolkits. Students will design a GUI based application. Prerequisite: CSC 550 Object Oriented Design and Data Structures.

CSC 612 Program Verification (3 credits)
Symbolic logic and mechanized deduction; program specification; loop invariants; the proof methods of Floyd and Hoare; parallel computations; program semantics.

Prerequisite: CSC 551 Design and Analysis of Algorithms.

CSC 613 Software Testing (3 credits)
A systematic approach to software testing, in context of the software life cycle and as a branch of software engineering, building on students' prior knowledge of software engineering. Through both the breadth and depth of its coverage, the course prepares students to make an effective contribution to software testing as professional software engineers. Prerequisite: CSC 610 Software Engineering.

Web and Database Technologies Courses

CSC 620 Internet Application Development (3 credits)
This course will attempt to give you experience in designing Internet applications. A student finishing this course should be able to design, implement, and maintain a large community or e-commerce web site. They should leave the course with an understanding of a variety of Internet protocols and markup languages, a knowledge of at least one common scripting tool, an understanding of how to implement a database back-end into a large-scale site, and the ability to critically assess the usability of both their design and the design others.

CSC 621 Database Systems (3 credits)
This course covers the concepts and structures necessary to design and implement a database management system. Topics to be covered: data models (entity-relationship and relational), SQL, normalization, storage structures, enterprise applications and database integrity. Prerequisite: CSC 621 Database System.

CSC 622 Advanced Database Concepts (3 credits)
Topics include stored procedures, triggers, query processing and optimization, web-based enterprise data applications, transaction management, concurrency control, distributed databases, data mining and web mining. The course includes programming projects involving SQL. Prerequisite: CSC 621 Database System.

CSC 623 Data Communications and Networking (3 credits)
Topics include mathematical foundations of data communications, logical and physical organization of computer networks, the ISO and TCP/IP models, communication protocols, circuit and packet switching, the Internet, LAN/WAN, client/server communications via sockets, routing protocols, data encryption/decryption and network security issues. Prerequisite: CSC 550 Object Oriented Design and Data Systems.

CSC 626 Web Technologies (3 credits)
Topics include organization of Meta-Markup languages, Document Type Definitions (DTDs), document validity and well-formedness, style languages, namespaces, Transformations, XML parsers, Web Services, and Web Security Specifications. Course includes programming projects. Prerequisite: CSC 550 Object Oriented Design and Data Structures.

CSC 627 Introduction to Security (3 credits)
Topics include fundamental concepts in confidentiality, integrity, and availability, access control methods, cryptographic concepts, physical security, malware, computer viruses, privacy-invasive software, malware detection, network security, web security, security models, software vulnerability assessment.

CSC 628 Advanced Security (3 credits)
Topics include classical cryptosystems, public and symmetric cryptography, key management, digital signatures, cipher techniques, authentication and federated identity management. Course also covers concepts relating to cryptovirology, malware, viruses, Trojan horses, worms and other types of infectors as they relate to network security. Course includes programming projects. Prerequisite: CSC 550 Object Oriented Design and Data Structures.

Graphics and Visualization Courses

CSC 630 Introduction to Graphics (3 credits)
The course provides an introduction to the principles of computer graphics. The emphasis will be placed on understanding how various elements that underlie computer graphics interact in the design of graphics software systems. Topics include pipeline architecture, graphics programming, 3D geometry and transformations, modeling, viewing, clipping and projection, lighting, shading and texture mapping and visibility determination. A standard graphics API will be used to reinforce concepts and the study of basic graphics algorithms. Students need some proficiency in C language and basic concepts from Linear Algebra.

CSC 631 Computer Vision (3 credits)
Computer vision is the science of analyzing images and videos in order to recognize or model 3D objects, persons, and environments. Topics include the underlying image formation principles, extracting simple features like prominent points or lines in images, projecting a scene to a picture, tracking features and areas in images and make a mosaic, making an image-based positioning system, obtaining 3D models from two or more images, and techniques to recognize simple patterns and objects. The class includes programming exercises and hands-on work with digital cameras and laser scanners. Prerequisite: CSC 550 Object Oriented Design and Data Structures.

CSC 632 Interactive 3D Game Development (3 credits)
This is a technology-based course that uses the latest computer games technology to teach advanced programming, mathematics, and software development. The course is ideal for students with an interest in computer games who plan to seek employment in one of the country's more profitable industries, or students looking for a career in new technologies or software development. The interactive entertainment industry in the US and throughout the world is entering a new phase. New technology platforms are forcing existing development firms to diversify. There are many aspects of game design, development, production, finance, and the distribution process. This course specializes in the programming and technology aspects of the industry. Prerequisite: CSC 550 Object Oriented Design and Data Structures.

CSC 633 Advanced Computer Graphics and Visualization (3 credits)
The goal of this course is to expose students to advanced techniques in modeling and rendering in computer graphics and visualization. Topics include parametric curves and surfaces, mesh representation, multiresolution modeling, mesh simplification, ray-tracing, radiosity and volume rendering (iso-rendering and direct volume rendering), anti-aliasing and animation. Prerequisite: CSC 630 Introduction to Graphics.

CSC 634 Computational Geometry (3 credits)
The course covers design, implementation and analysis of data structures and algorithms for solving geometric problems concerning objects like points, lines, polygons in 2-dimensional space and in higher dimensions. The course emphasizes the applications of computational geometry. Topics include overview of geometric concepts, curves and surfaces, data structures for representing solid models, convex hulls, line segment intersection, multi-dimensional data structures (kd-trees, quadtrees and BSP trees), and range searching, point location, triangulations and Voronoi diagrams. Prerequisite: CSC 551 Design and analysis of Algorithms.

Free Distribution Courses

CSC 670 Topics in Computer Science (3 credits)
The course introduces students to recent theoretical or practical topics of interest in computer science. Content and structure of the course are determined by the course supervisor. The special topics for a given semester will be announced prior to registration. With permission of the Graduate Director the course may be taken more than once. Prerequisite: CSC 550 Object Oriented Design and Data Structures or permission of instructor.

CSC 680 Artificial Intelligence (3 credits)
The course covers fundamental concepts such as role of logic in reasoning, deductive proofs, and blind and informed search techniques. Additional topics may include inductive learning, genetic algorithms, decision trees, planning, natural language processing, game trees and perception learning. Course includes programming projects in a suitable language. Prerequisite: CSC 550 Object Oriented Design and Data Structures

CSC 681 Programming Paradigms (3 credits)
An exploration of the relationships between computational paradigms and the computer languages that support them. The Lambda calculus and functional programming, resolution and logic based languages, machine based models and imperative languages. The impact of the computational model on program structure and language design. A mid-sized programming project will be used to illustrate the concepts. Prerequisite: CSC 500 Discrete Structures.

CSC 682 Numerical Algorithms (3 credits)
Exposition and analysis of numerical methods for modern computers; review of basic concepts in linear algebra; direct and interactive methods for solving linear and nonlinear problems in numerical algebra; basic problems in approximation theory, numerical differentiation and integration; numerical solutions of different equations; forward and backward error analysis of algorithms; criteria for comparing the efficiency and suitability of numerical methods. Prerequisite: CSC 500 Discrete Structures.

CSC 683 Information Theory and Coding (3 credits)
Data encoding and transmission; variable length coding; the Kraft inequality for noiseless transmission channels; channel capacity; noise channels and channel capacity; the Shannon coding theorem; algebraic coding schemes. Prerequisite: CSC 551 Design and Analysis of Algorithms, CSC 554 Theory of Computation.

CSC 684 Complexity of Computation (3 credits)
P and NP problems; NP-complete classes; concrete complexity and the P class of combinatorial problems; complexity reduction on graph and string problems; complexity of algebraic computations. Prerequisite: CSC 551 Design and Analysis of Algorithms.

CSC 690 Internship (3 credits)
An approved internship in advanced computer science.

CSC 791 Research Project I (3 credits)
Supervised independent research mentored by a graduate faculty member. Prerequisite: GPA of 3.5 and permission of the Graduate Director.

CSC 792 Research Project II (3 credits)
Supervised independent research mentored by a graduate faculty member. Prerequisite: GPA of 3.5 and permission of the Graduate Director.

CSC 793 Research Project I/II (6 credits)
Supervised independent research mentored by a graduate faculty member. Prerequisite: GPA of 3.5 and permission of the Graduate Director.