Master of Science

in

Computer Science

Department of Computer Science
Jordan University of Science and Technology
Faculty of Computer and Information Technology

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Preface

The demand on IT higher education has witnessed an astonishing increase in the Hashemite Kingdom of Jordan and worldwide, which is derived by many factors related to the continuous and ever-increasing competition from educational institutes and IT industries to attract IT professionals from all over the globe. This tight global completion has left our national IT educational systems in a difficult situation in terms of fulfilling staffing needs, particularly qualified instructors and faculty members. This is true not only for Jordan University of Science and Technology but also for many schools around the Hashemite Kingdom of Jordan.

One obvious solution to the problem of supplying the badly needed instructional staff is through a higher educational system that delivers the required expertise. In fact, the Dean's Council in Jordan University of Science and Technology has decided on May 2003 to establish a graduate program that leads to a master degree in Computer Science. In compliance with this resolution, the Department of Computer Science is offering a master program. The master program is designed to

- deliver a solid curriculum in computer science, which conforms to guidelines laid by the down College of Graduate Studies at Jordan University of Science and Technology.
- guarantee liberal choices to its candidates so that they can pick and choose from the various elective topics and emphasis areas that best fit their future career endeavors.
- supply our local industries and educational systems with qualified IT educationalists.
- emphasize the significance of conducting applied research that has direct impact on the concerns of the local community.
- prepare qualified candidates for further higher education opportunities.
- establish collaborative links and joint research programs in other departments in and outside the University.

MINIMUM ADMISSION REQUIREMENTS

Applicants to the master's program in Computer Science should comply with the rules and regulations of the master's program at the University issued by the Dean's council in 1997, resolution number 606/97.

THESIS TRACK

This track requires successfully defending a 9-credit master thesis that complies with the University guidelines plus the completion of 25 credit hours of graduate course work. These 34 credit hours are distributed as follows:

- 10 credit hours of core course work.
- 15 credit hours of electives selected from list B with advisor approval.
- 9 credit hours of thesis work.

The prerequisite information for all CS graduate courses will be resolved case-by-case (for each applicant) as approved by the CS Department Board.

A) Core Courses for the Thesis Track (16 Credit hours).

Course Code	Course Name	Credits
CS 728	Advanced Database Systems	3
CS 742	Advanced Computer Networks	3
CS 762	Advanced Artificial Intelligence	3
CS 775	Advanced Operating Systems	3
CS 784	Advanced Algorithms	3
CS 789	Seminar in Advanced Computer Science Topics	1

B) Elective Courses for the Thesis Track (9 Credit hours).

Course Code	Course Name	Credits
CS 711	Advanced Software Engineering	3
CS 713	Software Project Management and Quality Assurance	3
CS 718	Advanced Topics in Human-Computer Interaction	3
CS 721	Information Retrieval Systems	3
CS 722	Natural Language Processing	3
CS 727	Object Oriented Databases	3
CS 729	Advanced Methods in Data Mining	3
CS 731	Theory of Programming Languages	3
CS 751	Advanced Computer Architecture	3
CS 752	Advanced Robotics	3
CS 753	Advanced Computer and Network Security	3
CS 754	Advanced Parallel and Distributed Computing	3
CS 763	Machine Learning	3
CS 764	Recommender Systems	3
CS 766	Advanced Expert Systems	3
CS 771	Theory of Languages, Automata, and Complexity	3
CS 772	Formal Compiling Methods	3
CS 781	Advanced Computer Graphics	3
CS 782	Advanced Image Processing	3
CS 783	Advanced Computer Vision	3
CS 785	Advanced Multimedia Systems and Networks	3
CS 786	Advanced Modeling and Simulation	3
CS 787	Advanced Bioinformatics	3
CS 788	Advanced Computational Geometry and Applications	3

CS 795	Selected Topics in Computer Science 1	3
CS 796	Selected Topics in Computer Science 2	3
CS 797	Selected Topics in Computer Science 3	3
	Up to 3 credit hours graduate courses selected from other Departments with advisor approval	0-6

C) Thesis (9 Credit hours)

Course Code	Course Name	Credits
CS 799a	Master's Thesis	9
CS 799b	Master's Thesis	6
CS 799c	Master's Thesis	3
CS 799d	Master's Thesis	0

NON-THESIS TRACK

This track requires the completion of 34 credit hours of graduate course work and passing a comprehensive examination.

The 34 credit hours of required graduate course work are distributed as follows:

- 19 credit hours of core course work.
- 15 credit hours of elective selected from list B with advisor approval.

A) Core Courses for the Non-Thesis Track (19 Credit hours)

Course Code	Course Name	Credits
CS 711	Advanced Software Engineering	3
CS 728	Advanced Database Systems	3
CS 742	Advanced Computer Networks	3
CS 775	Advanced Operating Systems	3
CS 784	Advanced Algorithms	3
CS 789	Seminar in Advanced Computer Science Topics	1
CS 790	Project	3
CS 798	Comprehensive Exam	0

B) Elective Courses for the Non-Thesis Track (15 Credit hours).

Course Code	Course Name	Credits
CS 713	Software Project Management and Quality Assurance	3
CS 718	Advanced Topics in Human-Computer Interaction	3
CS 721	Information Retrieval Systems	3
CS 722	Natural Language Processing	3
CS 727	Object Oriented Databases	3
CS 729	Advanced Methods in Data Mining	3
CS 731	Theory of Programming Languages	3
CS 751	Advanced Computer Architecture	3
CS 752	Advanced Robotics	3
CS 753	Advanced Computer and Network Security	3
CS 754	Advanced Parallel and Distributed Computing	3
CS 762	Advanced Artificial Intelligence	3
CS 763	Machine Learning	3
CS 764	Recommender Systems	3
CS 766	Advanced Expert Systems	3
CS 771	Theory of Languages, Automata, and Complexity	3
CS 772	Formal Compiling Methods	3
CS 781	Advanced Computer Graphics	3
CS 782	Advanced Image Processing	3
CS 783	Advanced Computer Vision	3
CS 785	Advanced Multimedia Systems and Networks	3
CS 786	Advanced Modeling and Simulation	3
CS 787	Advanced Bioinformatics	3
CS 788	Advanced Computational Geometry and Applications	3
CS 795	Selected Topics in Computer Science 1	3

CS 796	Selected Topics in Computer Science 2	3
CS 797	Selected Topics in Computer Science 3	3
	Up to 3 credit hours graduate courses selected from other Departments with advisor approval	0-6

C) Passing the Comprehensive Exam (CS 798).

CS 711 Advanced Software Engineering *3 Credit Hours*

Study of advanced principles and practices in software engineering-including evolutionary software development, software prototyping, object-oriented analysis and design, software system architectures, software project management, software testing, software metrics and measurement, software quality assurance, software reuse, software maintenance, reverse engineering, and computer-aided software engineering.

CS 713 Software Project Management and Quality Assurance *3 Credit Hours*

Managing people, management by metrics, feasibility and early planning, models for managerial planning, software quality assurance, software resource estimation, and reliability.

CS 718 Advanced Topics in Human-Computer Interaction *3 Credit Hours*

This course depicts the state of the art in Human-Computer Interactions by critically guiding the student through a selection of recent texts on the subject.

CS 721 Information Retrieval Systems *3 Credit Hours*

Design concepts and approaches, vocabulary control and indexing languages, text retrieval issues (such as parallel retrieval, retrieval algorithms, stemming algorithms, parallel query-document comparison functions, output ranking, association weighting, etc.), searching models (building block, citation pearl growing, successive fractions, most specific facet first, lowest posting first, etc.), retrieval effectiveness (relevance, precision and recall, probability ranking, retrieval limits etc.), information retrieval experiments methodologies, case studies (such as Cranfields, Medlars, Thomas, CONIT, etc.), and retrieval languages.

CS 722 Natural Language Processing *3 Credit Hours*

An introduction to the problems of computing with human languages. Parsing. Semantic representations. Text generation. Lexicography. Discourse. Sublanguage studies. Applications to CAI, database interfaces and information retrieval.

CS 727 Object-Oriented Databases *3 Credit Hours*

Basic concepts for using object databases. Complex data. Comparing the Object and Relational models. Types of products that handle objects. DBMS standards for objects. The OMG Object Model. Object SQL (A language for the design and implementation of object databases. OQL "C++": Extending C++ with an object query capability. C++ bindings to an object database. View support in object-oriented database systems. Authorization in object-oriented databases. Query Processing in object-oriented database systems. Physical object management.

Versions. Object-oriented Database Systems: Promises, Reality, and Future. Where Object-Oriented DBMS Should Do Better: A Critique Based on Early Experiences.

CS 728 Advanced Database Systems *3 Credit Hours*

Enhanced Entity-Relationship (EER) and object modeling. EER to relational model mappings, tuple relational calculus and domain relational calculus, overview of Query By Example (QBE), database systems architecture and system catalog, query processing and optimization, transaction processing concepts, concurrency control techniques, database recovery techniques, database security and authorization, enhanced data models and advanced applications (object-relational and extended-relational models).

CS 729 Advanced Methods in Data Mining *3 Credit Hours*

Advanced techniques in data mining Topics may include: Association Rule Mining, Classification, Clustering, Text Mining, Knowledge Extraction, Web Information Retrieval, Mediators, Wrappers and Data Warehousing, Web Mining and Crawling, Decision Trees, Statistical Methods, Pattern Recognition and Machine Learning Techniques.

CS 731 Theory of Programming Languages *3 Credit Hours*

An exploration of modern or unconventional concepts of programming languages, their semantics, and their implementations; abstract data types; functional, object-oriented, logic programming, and concurrency. Example languages include ML, Ada, Oberon, PROLOG, Modula 2, and CSP.

CS 742 Advanced Computer Networks *3 Credit Hours*

Wired and Wireless Networks, Channel Propagation Model, Multiple Access, High-speed networks, ISDN, N-ISDN, B-ISDN, Multimedia Networks, Optical Networks, Bandwidth allocation, flow control, Design and performance issues, Frame Relay, Congestion Control, Applications, ATM, Traffic Management, Quality of Service, Voice/IP, IP/ATM, Mobile Communication Fundamentals, Generic Mobile Network, GSM Cellular, and Current research directions.

CS 751 Advanced Computer Architecture *3 Credit Hours*

Array, parallel, and pipeline architectures; multiple processor systems, and concepts of data flow and high-order language architectures. Performance evaluation of computer systems.

CS 752 Advanced Robotics *3 Credit Hours*

This course introduces fundamental concepts in Robotics. Basic concepts discussed will include: coordinate transformation, kinematics, dynamics, Laplace transforms, equations of motion, feedback and feedforward control, and trajectory planning. These topics will be exemplified with MATLAB/Simulink simulation studies. The

second half of the course will focus on applying the knowledge from the initial lectures to various motor systems, including manipulators, artificial eye systems, locomotory systems, and mobile robotics.

CS 753 Advanced Computer and Network Security *3 Credit Hours*

This course is intended to give the students the principles and concepts of computer security. The students should be able to understand what it means for a system to be secure. Furthermore, the students will get to know about computing systems vulnerabilities, threats, and security controls. The course includes the following topics: Introduction to cryptography, confidentiality, authentication, digital signatures, program security, operating systems security, and network security. Research component is part of this course.

CS 754 Advanced Parallel and Distributed Computing *3 Credit Hours*

The course is centered on three concepts: Architectures, Algorithms and Programming. Parallel and Distributed architectures: parallel and distributed computers taxonomy, examples of parallel and distributed computers, fundamental communication operations, and performance metrics. Parallel algorithms: design and analysis of parallel algorithms with emphasis on sorting, matrix problems, and graph problems. Parallel programming: types of parallelism, parallel programming paradigms, message passing programming, data and parallel programming.

CS 762 Advanced Artificial Intelligence *3 Credit Hours*

AI concepts and methods for problem solving, heuristic search, planning, hypothesis formation, modeling and knowledge representation, knowledge acquisition (learning), and AI's programming methodologies and tools. Applications of AI in areas of automatic programming, theorem proving, game playing, machine vision, natural language systems, and robots. Mobile agents and probabilistic reasoning.

CS 763 Machine Learning *3 Credit Hours*

Machine Learning is centered around automated methods that improve their own performance through learning patterns in data, and then use the uncovered patterns to predict the future and make decisions. Examples include document/image/handwriting classification, spam filtering, face/speech recognition, medical decision making, robot navigation, to name a few. See this for an extended introduction. This course covers the theory and practical algorithms for machine learning from a variety of perspectives. The topics include Bayesian networks, decision tree learning, Support Vector Machines, statistical learning methods and unsupervised learning, as well as theoretical concepts such as the PAC learning framework, margin-based learning, and VC dimension. Short programming assignments include hands-on experiments with various learning algorithms, and a larger course project gives students a chance to dig into an area of their choice. See the syllabus for more. This course is designed to give a graduate-level student a

thorough grounding in the methodologies, technologies, mathematics and algorithms currently needed by people who do research in machine learning.

CS 764 Recommender Systems *3 Credit Hours*

In this class, the focus is on obtaining a general understanding of state of the art user modeling techniques and recommendation mechanisms. The student will learn to critically discuss relevant topics and apply the mechanisms to different domains. They will do a course project where groups of students virtually design a system that explicitly models the user and provide recommendations in a domain chosen by the group. Students will learn about the techniques through presentations; reading/discussing seminal papers in the user modeling and recommendation literature and interactive experiments during the lecture hours. Each student will either write a survey of one chosen topic that relates to the student's interest/background or an implementation of a simple system (eg. mobile application, design prototype).

CS 766 Advanced Expert Systems *3 Credit Hours*

Expert systems concepts and their architectures. Languages and tools for knowledge engineering. Heuristic versus algorithmic methods, treatment of heuristics as used in expert systems, and heuristic programming techniques. Class and individual projects to illustrate concepts.

CS 771 Theory of Languages, Automata, and Complexity *3 Credit Hours*

The course presents several topics in Theory of Languages, Automata, and Complexity such as Finite-state, context-free, context-sensitive, recursive languages, Turing machines, primitive recursive functions, Partial recursive functions, Chomsky hierarchy, Rice's theorem, Church's Thesis, Reducibility and completeness, Time complexity and NP-completeness, Probabilistic computation, and Interactive proof systems.

CS 772 Formal Compiling Methods *3 Credit Hours*

The course presents several topics in Formal Compiling Methods: Lexical analysis, syntactic analysis, error detection, translation into intermediate code, storage allocation, optimization techniques. Models of syntactic analysis, including canonical precedence, LR(k) and LL(k) parsing methods and variants; efficiency of each. Also, this course covers Synthesis techniques including symbol tables, storage administration, parameter mechanisms, garbage collection; optimization considerations. Models of synthesis, including level, affix, attributed grammars. Students are expected to complete a large programming project as part of the course.

CS 775 Advanced Operating Systems *3 Credit Hours*

Process Management: process concepts; asynchronous concurrent processes; deadlock and indefinite postponement; Storage Management: real storage; virtual storage organization; virtual storage management; Process Management: job and processor scheduling; Auxiliary Storage Management: disk performance optimization; Review of multiprogramming operating systems including process distributed memory multiprocessors and distributed systems. Topics include distributed file systems, concurrency, and distributed process coordination. Introduction to network communication issues and special purpose systems such as real-time systems, transaction processing systems, and client-server technology. Network Operating Systems; Distributed Operating Systems.

CS 781 Advanced Computer Graphics *3 Credit Hours*

Overview of display devices and applications. Vector graphics in two and three dimensions. Image generation, representation, and manipulation. Homogeneous coordinates. Modeling and hidden line elimination. Introduction to raster graphics. Perspective and parallel projections. Advanced topics in computer image generation. Scene representation: parametric surfaces, stochastic modeling, procedurally defined objects, volumetric models. Image rendering: scanline and ray-tracing algorithms, smooth shading and coloring, texture and bump mapping. Anti-aliasing. Additional course content variable, depending on state of the art and current research trends.

CS 782 Advanced Image Processing *3 Credit Hours*

Review of image formation and acquisition; image transformation; image enhancement and restoration; image compression; morphological image processing; edge detection and segmentation; architecture for image processing. Research component is part of this course.

CS 783 Advanced Computer Vision *3 Credit Hours*

Study of Morphological Image Processing, Image Segmentation, Image Representation, Feature Selection and Feature Extraction, Finding in Digital Image Libraries, and other Advanced Learning Techniques and Their Application on Content-based Image Retrieval such as Support Vector Machines for Object Recognition, Multiple-Instance Learning, Automatic Image Annotation, and Image Clustering. Research component is part of this course.

CS 784 Advanced Algorithms *3 Credit Hours*

The course offers advanced concepts in: Strategies of algorithms synthesis and analysis. Design methodologies of classical algorithm categories such as: divide-and-conquer, greedy method, dynamic programming, search and traversal, backtracking, and branch-and-bound. Computational complexity and important theoretical results from lower-and upper-bound studies, NP-hard, and NP-complete problems.

CS 785 Advanced Multimedia Systems and Networking *3 Credit Hours*

Advanced coverage of the principles and the current technologies of multimedia system design and gain hands-on experience in this area. Topics include multimedia systems design, multimedia hardware and software, issues in effectively representing, processing, and transmitting multimedia data such as text, graphics, sound and music, image and video.

CS 786 Advanced Modeling and Simulation *3 Credit Hours*

The course covers advanced topics in modeling of complex systems using both discrete and continuous models. This course focuses in modeling and simulation methodologies considering both practical and theoretical aspects. The course covers advanced topics for modeling complex real problems. The course also covers a comprehensive review on continuous, discrete, (discrete/continuous) hybrid simulation. This includes several modeling techniques such as Agent-based modeling techniques and their application in real-world problem. Research component is part of this course.

CS 787 Advanced Bioinformatics *3 Credit Hours*

This course focuses on the several advanced algorithms and models used in various bioinformatics applications. Needs and opportunities for improving such algorithms are discussed in the context of current and future problems in bioinformatics. The course aims to utilize and develop the existing frameworks and tools in to study and explore biological systems such as diseases development. Research component is part of this course.

CS 788 Advanced Computational Geometry and Applications *3 Credit Hours*

The course presents several of geometric algorithms that help student to understand the various considerations and tradeoffs used in designing geometric algorithms such as space, time, and robustness, in several applications. The course covers the basic geometric data structures and algorithms, their complexity, implementation and applications. The Course covers several topics such as: Proximity and Intersection, Voronoi Diagrams and Delaunay Triangulation, Linear Programming in Lower Dimension, Geometric Search, Arrangements of Hyperplanes, Convex Hulls, Polytopes and Computation, Numerical Robustness, Randomized Algorithms. The course focuses on the applications of geometric algorithms and data structures in the several research areas. Research component is part of this course.

CS 789 Seminar in Advanced Computer Science Topics *1 Credit Hour*

By studying this course, students will be taught how to write a proposal, find related material (in the library, on the web, etc), present their work in front of audience, defend their work, know art of writing scientific papers, etc.

CS 790 Project *3 Credit Hours*

The student implements, tests and presents a project. Also a written report should be submitted to the Department and the project supervisor.

CS 795 Selected Topics in Computer Science 1 *3 Credit Hours*

Appropriate coverage in terms of breadth and depth of a selected area that reflects the state of the art in computer science.

CS 796 Selected Topics in Computer Science 2 *3 Credit Hours*

Appropriate coverage in terms of breadth and depth of a selected area that reflects the state of the art in computer science.

CS 797 Selected Topics in Computer Science 3 *3 Credit Hours*

Appropriate coverage in terms of breadth and depth of a selected area that reflects the state of the art in computer science.

CS 798 Comprehensive Exam *0 Credit Hours*

This course consists of a comprehensive exam covering all the material taken by the student during his/her course of study. The exam takes place in the department and is administered by a number of specialized faculty members.

CS 799a Master's Thesis *9 Credit Hours*

Program of research leading to an M. Sc. degree, arranged between a student and a faculty member.

CS 799b Master's Thesis *6 Credit Hours*

Program of research leading to an M. Sc. degree, arranged between a student and a faculty member.

CS 799c Master's Thesis *3 Credit Hours*

Program of research leading to an M. Sc. degree, arranged between a student and a faculty member.

CS 799d Master's Thesis *0 Credit Hours*

Program of research leading to an M. Sc. degree, arranged between a student and a faculty member.

Appendix B: List of Graduate Courses

Course Code	Course Name	Credits
CS 701	Foundations of Computer Science	3
CS 711	Advanced Software Engineering	3
CS 713	Software Project Management and Quality Assurance	3
CS 718	Advanced Topics in Human-Computer Interaction	3
CS 721	Information Retrieval Systems	3
CS 722	Natural Language Processing	3
CS 727	Object Oriented Databases	3
CS 728	Advanced Database Systems	3
CS 729	Advanced Methods in Data Mining	3
CS 731	Theory of Programming Languages	3
CS 742	Advanced Computer Networks	3
CS 751	Advanced Computer Architecture	3
CS 752	Advanced Robotics	3
CS 753	Advanced Computer and Network Security	3
CS 754	Advanced Parallel and Distributed Computing	3
CS 762	Advanced Artificial Intelligence	3
CS 763	Machine Learning	3
CS 764	Recommender Systems	3
CS 766	Advanced Expert Systems	3
CS 771	Theory of Languages, Automata, and Complexity	3
CS 772	Formal Compiling Methods	3
CS 775	Advanced Operating Systems	3
CS 781	Advanced Computer Graphics	3
CS 782	Advanced Image Processing	3
CS 783	Advanced Computer Vision	3
CS 784	Advanced Algorithms	3
CS 785	Advanced Multimedia Systems and Networks	3
CS 786	Advanced Modeling and Simulation	3
CS 787	Advanced Bioinformatics	3
CS 788	Advanced Computational Geometry and Applications	3
CS 789	Seminar in Advanced Computer Science Topics	1
CS 790	Project	3
CS 795	Selected Topics in Computer Science 1	3
CS 796	Selected Topics in Computer Science 2	3
CS 797	Selected Topics in Computer Science 3	3
CS 798	Comprehensive Exam	0
CS 799a	Master's Thesis	9
CS 799b	Master's Thesis	6
CS 799c	Master's Thesis	3
CS 799d	Master's Thesis	0