Master of Science

in

Computer Engineering

PREFACE

The demand on higher education in the field of computer engineering and information technology has witnessed a tremendous increase in the Hashemite Kingdom of Jordan as well as worldwide. This demand has been the main driving force behind the continuous increase in competition among educational institutes to attract IT professionals from all over the globe. This tight global competition has resulted in a severe shortage of IT professionals in the local educational institutions, particularly qualified instructors and faculty members.

As a contribution to the remedy to the current situation, the department of computer and Internet Engineering is offering its Master of Science program. Our graduates will help JUST, as well as other Jordanian and regional universities find high standard staff, thus fulfilling their goals in offering high standard curricula to their students.

The proposed program is designed to

- Deliver a solid curriculum in computer engineering, which conforms to guidelines laid down by the College of Graduate Studies at Jordan University of Science And Technology.
- Offer the graduate student some sort of flexibility in choosing his line of knowledge by increasing the number of elective courses and reducing the number of mandatory courses.
- 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 and needs of the local community.
- Prepare qualified candidates for further higher education opportunities.
- Establish collaborative links and joint research programs with other departments inside and outside the university.

MINIMUM ADMISSION REQUIREMENTS

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

THESIS OPTION CURRICULUM

This option 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 with advisor approval. Up to 6 credit hours of these electives can be taken from outside the department upon the approval of the supervisor and the Department Graduate Committee.
- 9 credit hours of thesis work.

The prerequisite information for all CIE graduate courses will be resolved on a case-by-case basis (for each candidate) upon the decision of the CIE Department Board.

A) Core Courses for the Thesis Option (10 Credit hours)

Course Code	Course Name	Credits
CIE 740	High-Performance Computer Architecture	3
CIE 760	Advanced Operating Systems	3
CIE 770	Advanced Computer Networks	3
CIS 780	Seminar in Computer Engineering	1

B) Elective Courses for the Thesis Option (15 Credit hours).

Course Code	Course Name	Credits
CIE 712	Computational Graph Theory	3
CIE 714	Queuing Systems and Performance models	3
CIE 742	Distributed Systems	3
CIE 745	Parallel Computing	3
CIE 746	Embedded Real-Time Systems	3
CIE 748	VLSI Design	3
CIE 749	Fault Tolerant Digital Systems	3
CIE 750	Digital Image Processing	3
CIE 751	Artificial Intelligence and Machine Learning	3
CIE 752	Computer Vision	3
CIE 754	Neural Networks	3
CIE 756	Fuzzy Systems	3
CIE 759	Robotics	3
CIE 761	Compiler Structures	3
CIE 765	Advanced Software Engineering	3
CIE 763	Advanced Algorithms and Data Structures	3
CIE 772	Multimedia Networking and Communication	3
CIE 773	Storage Area Networks	3
CIE 774	Advanced Internet Systems	3
CIE 776	Computer Networking Security	3
CIE 779	Special Topics in Computer Engineering	3

	Up to 2 Graduate Courses from other departments/faculties[1]

C) Thesis (9 Credit hours)

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

[1] Supervisor and Department Graduate Committee approvals are required

WORK PLAN (THESIS OPTION)

The recommended work plan for thesis option is summarized in the subsequent tables. Although the thesis will be registered in the last semester, it is highly recommended that a student choosing this option start thinking about and discussing his/her thesis topic with faculty members ahead of time. Developing a successful thesis usually requires more than one semester.

First semester / First year

Course Code	Course Name	Credits
CIE 740	High-Performance Computer Architecture	3
CIE 760	Advanced Operating Systems	3
CIS 780	Seminar in Computer Engineering	1
Total		7

Second semester / First year

Course Code	Course Name	Credits
CIE 770	Advanced Computer Networks	3
	Elective Course	3
	Elective Course	3
Total		9

First semester / Second year

Course Code	Course Name	Credits
	Elective course	3
	Elective course	3
	Elective course	3
Total		9

Second semester / Second year

Course Code	Course Name	Credits
CIE 799a	Master's Thesis	9
Total		9

NON-THESIS OPTION

This option 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 electives from the department graduate courses. Up to 6 credit hours of these electives can be taken from outside the department upon the approval of the Department Graduate committee.

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

Course Code	Course Name	Credits
CIE 740	High-Performance Computer Architecture	3
CIE 750	Digital Image Processing	3
CIE 751	Artificial Intelligence and Machine Learning	3
CIE 760	Advanced Operating Systems	3
CIE 763	Advanced Algorithms and Data Structures	3
CIE 770	Advanced Computer Networks	3
CIS 780	Seminar in Computer Engineering	1

B) Elective Courses for the Non-Thesis Option (15 Credit Hours)

Course Code	Course Name	Credits
CIE 712	Computational Graph Theory	3
CIE 714	Queuing Systems and Performance models	3
CIE 742	Distributed Systems	3
CIE 745	Parallel Computing	3
CIE 746	Embedded Real-Time Systems	3
CIE 748	VLSI Design	3
CIE 749	Fault Tolerant Digital Systems	3
CIE 752	Computer Vision	3
CIE 754	Neural Networks	3
CIE 756	Fuzzy Systems	3
CIE 759	Robotics	3
CIE 761	Compiler Structures	3
CIE 765	Advanced Software Engineering	3
CIE 772	Multimedia Networking and Communication	3
CIE 773	Storage Area Networks	3
CIE 774	Advanced Internet Systems	3
CIE 776	Computer Network Security	3
CIE 779	Special Topics in Computer Engineering	3
	Up to 2 Graduate Courses from other departments/faculties[2]	6

[2] Department Graduate Committee approval is required

WORK PLAN (NON-THESIS OPTION)

First semester / First year

Course Code	Course Name	Credits
CIE 740	High-Performance Computer Architecture	3
CIE 760	Advanced Operating Systems	3
CIS 780	Seminar in Computer Engineering	1
Total		7

Second semester / First year

Course Code	Course Name	Credits
CIE 763	Advanced Algorithms and Data Structures	3
CIE 770	Advanced Computer Networks	3
	Elective Course	3
Total		9

First semester / Second year

Course Code	Course Name	Credits
CIE 750	Digital Image Processing	3
	Elective Course	3
	Elective Course	3
Total		9

Second semester / Second year

Course Code	Course Name	Credits
CIE 751	Artificial Intelligence and Machine Learning	3
	Elective Course	3
	Elective Course	3
Total		9

CIE 712 Computational Graph Theory 3C

Review of basic results in graph theory. Complexity measures of algorithms. Basic algorithms: Depth-first search, breadth-first search, biconnectivity, strong connectivity, minimum spanning tree, shortest paths, transitive closure and optimum branching. Efficient algorithms for the maximum flow problem. Vertex and edge connectivities: Manager's theorems, connectivity testing algorithms based on network flow theory. Matchings: Hall's theorem, and the alternating chain theorems. Maximum matching algorithms for general and bipartite graphs. Algorithms for weighted matchings. Set manipulation algorithms and applications. Reducibility and dominators in program graphs. NP-complete graph problems and approximation algorithms

CIE 714 Queuing Systems and Performance Models 3C

This course assumes knowledge of introductory probability theory. Basic structure of a queuing system; Poisson arrival process and its properties; service distributions; performance measures of a queuing system; examples of queuing systems in equilibrium; finite and infinite server and population models; Markovian queues in equilibrium; method of stages---Erlangian distribution; bulk arrival and bulk service systems; networks of queues; open queuing networks with exponential servers; product-form solution; closed queuing networks; computational algorithms for queuing networks; the imbedded Markov chain technique: analysis of queues with general service distribution.

CIE 740 High-Performance Computer Architecture 3C

Principles of modern high performance computer and micro architecture: static vs. dynamic issues, pipelining, control and data hazards, branch prediction and correlation, cache structure and policies, RISC, CISC, superscalar processors. cost-performance and physical complexity analyses.

CIE 742 Distributed Systems 3C

Fundamental design: naming, synchronization, latency, and bandwidth. Architectural evolution and technological driving forces. Parallel programming models, communication primitives, programming and compilation techniques, multiprogramming workloads and methodology for quantitative evaluation. Latency avoidance through replication in small-scale and large-scale shared memory designs; cache-coherency, protocols, directories, and memory consistency models. Message passing: protocols, storage management, and deadlock. Efficient network interface, protection, events, active messages, and coprocessors in large-scale designs. Latency tolerance through prefetching, multithreading, dynamic instruction scheduling, and software techniques. Network design: topology, packaging, k-ary n-cubes,

performance under contention. Synchronization: global operations, mutual exclusion, and events. Alternative architectures: dataflow, SIMD, systolic arrays

CIE 745 Parallel Computing 3C

The course is centered on three concepts: Architectures, Algorithms and Programming. Parallel architectures: parallel computers taxonomy, examples of parallel 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 parallel programming, and shared-address space programming in threads.

CIE 746 Embedded Real-Time Systems 3C

Designing embedded real-time computer systems. Types of real-time systems, including foreground/background, non-preemptive multitasking, and priority-based pre-emptive multitasking systems. Soft vs. hard real time systems. Task scheduling algorithms and deterministic behavior. Ask synchronization: semaphores, mailboxes and message queues. Robust memory management schemes. Application and design of a real-time kernel.

CIE 748 VLSI Systems 3C

CMOS circuits, clocking strategies, sequential circuits, CMOS process flows, design rules, structured layout techniques, dynamic circuits, performance analysis, design optimization, device sizing, CMOS arithmetic login units, high speed carry chains, fast CMOS multipliers, CMOS memory cells, array structures, Design for testability, VLSI case studies.

CIE 749 Fault Tolerant Digital Systems 3C

Fault-tolerant digital system theory and practice, recent and classic fault-tolerant techniques based on hardware redundancy, time redundancy, information redundancy, and software redundancy, hardware and software reliability analysis, and example fault-tolerant designs.

CIE 750 Digital Image Processing 3C

Physical descriptions of continuous images; properties of the human visual system; sampling and quantization of image; matrix representation of image forming and image processing systems; unitary transforms; image compression enhancement, scene matching and recognition, and applications. Demonstrations. Students write image processing algorithms.

CIE 751 Artificial Intelligence and Machine Learning 3C

Study of automated reasoning; representing change and the effects of actions; problem solving and planning. Includes the development of working programs that search, reason, and plan intelligently. Controlling physical mobile robot systems that operate in dynamic, unpredictable environments is covered. Building smart embedded chips for machine learning.

CIE 752 Computer Vision 3C

Introduces the principles and the fundamental techniques for Computer Vision. Topics include programming aspects of vision, image formation and representation, multi-scale analysis, boundary detection, texture analysis, shape from shading, object modeling, stereo-vision, motion and optical flow, shape description and objects recognition (classification), and hardware design of video cards. AI techniques for Computer Vision are also covered.

CIE 754 Neural Networks 3C

Adaptive threshold elements, feed forward layered networks, Madaline rules, back propagation, optimal decision making. Learning by punish/reward. Adaptive gaming. Experimental and theoretical applications of neural networks to pattern recognition, speech recognition, and self-learning adaptive control systems.

CIE 756 Fuzzy Systems 3C

Fuzzy sets and basic operation, further operations on fuzzy sets, fuzzy relations and the extension principle, fuzzy arithmetic, linguistic variables and fuzzy-IF-THEN rules, Fuzzy logic and approximate reasoning, fuzzy rule base and inference engine. Fuzzy logic in control engineering, fuzzy and AI, fuzzy and pattern recognition, Fuzzy modeling.

CIE 759 Robotics 3C

Introduction to robotic systems. Mechanical manipulators, kinematics, manipulator positioning and path planning. Dynamics of manipulators. Robot motion programming, and control algorithm design, Robotic vision, sensing and the programming of robots.

CIE 760 Advanced Operating Systems 3C

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 (NOS); Distributed Operating Systems (DOS).

CIE 761 Compiler Structure 3C

Translators and interpreters for programming languages. Syntax of programming languages; syntax directed compilation. Parsing techniques: operator precedence, top down, bottom up and reductive strategies. Generation and optimization of machine code. Error handling: detection and correction. The run time environment, storage allocation

CIE 763 **Advanced Algorithms and Data Structures** **3C**

Design and analysis of noncommercial problems involving sorting, searching, scheduling, graph theory, and geometry. Design techniques such as approximation, branch-and-bound, divide-and-conquer, dynamic programming, greed, and randomization applied to polynomial and NP-hard problems. Analysis and space utilization. Implementation of Algorithms will be based on advanced data representation techniques and object oriented modeling.

CIE 765 **Advanced Software Engineering** **3C**

Project management, software tools, requirements and specification methods; top-down, bottom-up, and data-flow design. Structured programming, information hiding, programming language issues, and coding standards. Software development environments, fault tolerance principles, and testing. software reliability; engineering real-time systems; managing large software projects; resource estimation; validation and verification; or advanced programming environments.

CIE 770 **Advanced Computer Networks** **3C**

Network technologies: packet switching, cell switching, optical networks. Switching and routing: packet switch architectures, ATM switch architectures, Internet routers and their performance. End systems: network interface design, operating system support for high performance, protocol processing. Network control: traffic management, congestion (flow and rate) control, admission control. Applications demanding high-speed communication.

CIE 772 **Multimedia Networking and Communication** **3C**

Multimedia applications and requirements, multimedia traffic generation and characterization: audio compression, image and video compression standards (JPEG, H.261, MPEG-2 and H.263). Advances in networking technologies and protocols for multimedia applications: LAN technologies; broadband services to the home including ADSL, cable modems (IEEE 802.14), and Hybrid Fiber-Coax (HFC); Internet protocols including IP multicast, resource reservation protocols (ST2+, RSVP); ATM services and applications. Integrated Services in the Internet: network element, controlled load, and guaranteed QoS service specifications. Integrated services over specific link layers (ISSLL). Real-time transport protocol (RTP), RTP profiles and payloads. Audio-Video Conferencing Standards: the Internet architecture (SDP, SAP, SIP); ITU Recommendations H. 320 and H.323. Data Conferencing Standards: ITU Recommendation T.120. Real-time streaming protocol (RTSP)

CIE 773 **Storage Area Networks** **3C**

Introduces the network storage landscape, data flood and fluid data, data storage on open systems servers. SCSI systems servers and their limitations, volume managers and device drivers, software mirroring over LAN and WAN,

cashes in storage networks are covered. We investigate boosting availability and performance with RAID and disk Subsystems. SAN design, building better backup systems with SANs, fibre channel networking technology for storage networks (point-to-point, loop, fabrics), distributed intelligence data sharing in the SAN, plug and play storage with NAS are also covered. Applications include comparison of SAN and SAN technologies, mapping SCSI-3 (FCP), IP, VIA, HIPPI, IEEE 802.2, 802.3, 803.5, SBCCS, AAL5 of ATM and FICON protocols to fibre channel. Laboratories include the usage of SAN protocols at the hardware and software levels

CIE 774 Advanced Internet Systems 3C

HTTP, XML, ICE and W3C standards. Design of web spiders, exploration, indexing and scalable search engine query processing. Information retrieval, TF/IDF, latent semantic indexing, hypertext link analysis, result clustering. Website management, information integration, ecommerce, personalization, collaborative filtering, security and privacy. Case studies: Alta vista, Google, Ask Jeeves, Jango, Vignette, Strudel, Amazon, Webwatcher.

CIE 776 Computer Network Security 3C

Covers the fundamentals of data network security. Covers concepts of data security through different algorithms. Different concepts on cryptographic systems (software and hardware) are classified. Shift register sequences and DES, are introduced. The concepts of public and private key cryptography is developed. Aspects of cryptographic hardware and embedded system design. Covers new methods for efficient hardware implementations of high-speed embedded systems, e.g., smart cards, cryptographic processors and co-processors, special-purpose hardware for cryptanalysis, DSP chips, etc.

CIE 779 Special Topics in Computer Engineering 3C

CIE 780 Seminar in Computer Engineering 1C

CIE 785 Special Topics in Computer Engineering 3C

A specific topic in computer engineering selected by the instructor and studied in depth in class.

CIE 799a Master's Thesis 9C

CIE 799b Master's Thesis 6C

CIE 799c Master's Thesis 3C

CIE 799d Master's Thesis 0C