Master of Science in Computer Science
Program code: 041810

INTRODUCTION

The Computer Science Department (College of Science) offers a graduate program that leads to the degree of Master of Science in **Computer Science.** The program features a thesis and a non-thesis option. The thesis option requires a successful completion of a thesis, and the non-thesis option requires the completion of a project. The graduate program in Computer Science places equal emphasis on fundamentals and practical aspects of Computer Science. Current research interests of the faculty include: algorithms, artificial intelligence, database systems, networks and distributed systems, and software engineering. The aim of this program is to prepare students for industrial and research careers.

According to the University Council decision dated 4/2/2007, Thesis students admitted with effect from September 2007 are exempted from the comprehensive examination.

PROGRAM REQUIREMENTS

31 (34) TOTAL COURSE CREDITS (non-thesis option in parenthesis)

10 (13) COMPULSORY (credits in parenthesis)

0418-512	Automata and Formal Languages	(3)
0418-513	Theory of Complexity	(3)
0418-521	Programming Paradigms	(3)
0418-590	Research Seminar in Computer Science	(1)
0418-593	Project (non-thesis option only)	(3)

12 (21) ELECTIVES* (3 credits each)

0418-511 Algebraic Structures and Logic
0418-514 Principles of Programming Languages
0418-515 Program Specification and Verification
0418-516 Graph Theory
0418-522 Distributed Systems
0418-523 Advanced Databases
0418-524 Expert Systems
0418-525 Operating Systems
0418-526 Advanced Computer Networks
0418-527 Interconnection Networks
0418-534 Parallel Computing
0418-536 Advanced Computer Graphics
0418-541 Advanced Artificial Intelligence

0418-542 Scientific Computing: Mathematical Models & Algorithms
0418-543 Advanced Numerical Computing
0418-544 Software Engineering
0418-545 Computer Systems Architecture
0418-546 Design of Microprocessor-based Systems
0418-547 Modeling and Computer Simulation
0418-551 Introduction to Cryptography
0418-552 Data Mining
0418-553 Information Theory
0418-554 Wireless and Mobile Networks
0418-555 Design and Test of Digital Systems
0418-561 System & Network Security
0418-562 Software Security
0418-563 Data Protection and Privacy
0418-564 Computational Biology
0418-565 Computational Medicine
0418-566 Machine Learning
0418-567 Algorithms for Optimization
0418-580 Topics in Computer Science

***** Students may study up to 6 credit hours from the 400 level undergraduate courses offered by Computer Science Department or any 400/500 level courses offered by other Departments at Kuwait University with the approval of the Program Director.

9 COMPULSORY COURSES

0418-597	Thesis	(0)
0418-598	Thesis	(0)
2000-599	Thesis	(9)

COURSE DESCRIPTION

0418-511: ALGEBRAIC STRUCTURES AND LOGIC
CR: 3

Signature, algebras, semigroups, monoids, groups, rings. Homomorphisms and congruences. Term algebras. Signatures with predictable symbols, clauses, models. Conclusion and derivation, soundness and completeness. Predicate calculus. Skolem normal forms: clauses with variables, resolution principle.

0418-512: AUTOMATA AND FORMAL LANGUAGES
CR: 3

The classes of regular, context-free, context sensitive and recursively enumerable languages. Characterization by grammars. Deterministic and non-deterministic automata, pumping lemmats. Undecidable problems. Algebraic and decidability properties of the language classes.

0418-513: THEORY OF COMPLEXITY
CR: 3

Algorithm, Turing machines, computability. Complexity measures based on formal models, time and space, complexity. Tractable and intractable problems. Algorithm design techniques and analysis of the resulting algorithms. Complexity cases. P-NP problem, examples of NP-complete problems. Complexity of parallel computations.

0418-514: PRINCIPLES OF PROGRAMMING LANGUAGES
CR: 3

Imperative and applicative programming languages. Syntax, semantics, pragmatics. Compilation and interpretation. Syntactic domains, concrete and abstract syntax. Semantic domains, operational, denotational, and axiomatic semantics. Lambda calculus and typed lambda calculus.

0418-515: PROGRAM SPECIFICATION AND VERIFICATION
CR: 3

Total and partial correctness; Pre- and post conditions, verification rules, predicate transformers. Modal and temporal logic. Algebraic specifications, heterogeneous algebras, equations and conditional equations. Structured specifications, specification languages.

0418-516: GRAPH THEORY
CR: 3

The course covers the following topics: directed and undirected graphs, properties of graphs, graphs and subgraphs, trees, connectivity of graphs, Euler and Hamiltonian paths/cycles, Ram-sey's theorem, matching, coloring, independent sets and cliques, planar graphs, and networks.

0418-521: PROGRAMMING PARADIGMS
CR: 3

Features of imperative (procedural) programming languages, impacts of von Neumann computer architecture. Object-oriented programming paradigm, objects, classes, inheritance. Concepts of functional programming and LISP, functionals in programming. Concepts of logic programming and PROLOG.

0418-522: DISTRIBUTED SYSTEMS
CR: 3

Introduction to distributed systems: hardware and software concepts. Communication in distributed systems. Language support. Processing Concepts. Synchronisation scheduling and resource allocation. Distributed transaction processing.

0418-523: ADVANCED DATABASES
CR: 3

New data modelling concepts. Advanced transactions models. Conventional and parallel query processing. Database extensions (temporal databases). Data mining concepts.

0418-524: EXPERT SYSTEMS
CR: 3

Structure of Expert System. Classification of Experts Systems and main application areas. Basic cycle of work. Principles of Knowledge Engineering. Probability computations for Expert Systems. Reasoning under certainty and inexact reasoning. Fuzzy logic. Rete algorithm. Data structures for Expert Systems. Designing and developing Expert Systems with shells. CLIPS shell. Life cycles for Expert Systems.

0418-525: OPERATING SYSTEMS
CR: 3

Modern Operating systems design and construction techniques. Concurrent programming, operating system Kernels, correctness, transaction processing, synchronization problems, fault-tolerance, deadlocks, distributed system structures, distributed file systems and distributed coordination, protection and security, network operating systems, comparative structure of different kinds of operating systems, and other research topics.

0418-526: ADVANCED COMPUTER NETWORKS
CR: 3

Local area and wide-area networks, Internet protocols, TCP/IP, advanced topics in computer networking cellular and wireless, mobile communication systems and mobility management, ad hoc networks, sensor networks satellite networks, mobile IP, Bluetooth, network security and reliability.

0418-527: INTERCONNECTION NETWORKS
CR: 3

This course discusses the topological properties of interconnection networks, comparing differ-ent interconnection networks topologies, broadcasting and routing on some well-known inter-connection networks, fault tolerant broadcasting and routing on some well-known interconnec-tion networks, Hamiltonian cycles and Gray codes, and some problems in interconnection net-works.

0418-534: PARALLEL COMPUTING
CR: 3

Sequential and Parallel programs. A descriptive view at sequential and concurrent program execution. Parallel processing models and terminology. Architecture classifications. Communication topologies. Performance measures. Principles of organizing parallel algorithms and examples. Concurrent programming languages.

0418-536: ADVANCED COMPUTER GRAPHICS
CR: 3

Modeling real world with computer graphics. Data structures and data bases for computer graphics. Difficulties and methods for extracting spatial relation of objects. Simulating dynamics of objects. Interacting objects. Particle systems. Constrains in computer graphics. Textures and their designing. Architectures of advanced graphics workstations. Virtual reality systems.

0418-541: ADVANCED ARTIFICIAL INTELLIGENCE
CR: 3

Mathematical logic, resolution techniques and automated theorem proving. Problem solving methodology. Computational systems for problem solving. Sequential and parallel inference machines. Quasi-chaotic models of computations: Genetic algorithms. Game playing. Machine learning. Natural language processing: syntactic processing, semantic analysis. Selected application of AI.

0418-542: SCIENTIFIC COMPUTING: MATHEMATICAL MODELS AND ALGORITHMS
CR: 3

Mathematical modeling, using systems of differential equations to model real situations, large systems of linear equations, sparse matrices, pseudoinverse matrices, multilevel methods, factorization. Ordinary differential equations, initial-value problems, one step and multi-step methods for solution, stiff equations, boundary value problems, shooting, difference and variational methods.

0418-543: ADVANCED NUMERICAL COMPUTING
CR: 3

Fitting of data, B-spline representations, calculating with B-splines, knot insertion algorithms, curve fitting with splines, surface fitting, mesh data methods, scattered data methods. Transforms and filtration of data, Fourier transforms, convolution and correlation, sampling interpolation, deconvolution problem, reconstruction from projections, discrete projections, iterative image reconstruction. Data fitting with fractals, fractal image, fractal dimension, attractor, compression with quadtree, fractal image coding.

0418-544: SOFTWARE ENGINEERING
CR: 3

Models, notations, the process for software requirement identification, representation, validation, and analysis. Software design process and its models, design state assessment and quality assurance, design verification. Systematic testing of software systems and verification. Measurement and prediction of software reliability. Software project management.

0418-545: COMPUTER SYSTEMS ARCHITECTURE
CR: 3

Computational models and computer architecture. Instruction set design, processor architecture, memory organisation, I/O and interrupt system. Multiprocessor systems and interconnection networks, resource handling, case studies.

0418-546: DESIGN OF MICROPROCESSOR BASED SYSTEMS
CR: 3

Microprocessor systems and components; use of microprocessor systems for control applications. Design, implementation and test of several projects dedicated to microprogrammed control units, embedding microprocessors in control systems, and multiprocessor systems.

0418-547: MODELLING AND COMPUTER SIMULATION
CR: 3

Basic concepts of modelling, performance metrics, workload selection, data representation. Time-based vs. discrete-event simulation. Simulation of a single server system. Model validation and verification techniques. Random number generators, random variate generation, commonly used distributions. Simulation model analysis, initial transients, confidence intervals, output data analysis. Case studies.

0418-551: INTRODUCTION TO CRYPTOGRAPHY
CR: 3

The course starts with some examples of classical cipher systems such as affine cipher, substitution cipher, etc. Next we study some modern symmetric and asymmetric cipher systems and their security. Chaos-based cipher systems are also introduced. The diffie-hellman key exchange protocol is discussed. Digital signatures, hash functions and message authentication codes which are important tools for authentication and data integrity are also presented.

0418-552 : DATA MINING
CR: 3

Basic concepts, data preprocessing; Association rules, Classification and Prediction;. Cluster analysis; Evaluation Techniques; Specialized Techniques.

0418-553 : INFORMATION THEORY
CR: 3

Introduction to Algebra, Entropy, Linear codes, Cyclic codes, BCH codes, Hamming code, Huffman codes, Lempel-Ziv codes, Shannon–Fano codes, Channel capacity, Mutual infor-mation, Binary symmetric channel, Gaussian channel.

0418-554 : WIRELESS AND MOBILE NETWORKS
CR: 3

Fundamentals of wireless local area networks and wireless personal communication networks, network protocols, mobile and ad hoc networks, clustering and multicasting algorithms, mobile telecommunication protocols, handoff and channel allocation algorithms, cellular concepts, tradeoff between capacity and coverage, and frequency reuse, sensor networks, satellite networks, network reliability and performance measures.

0418-555: DESIGN AND TEST OF DIGITAL SYSTEMS
CR: 3

Logic design principles, Boolean algebra; logic simulation methods, structural hazards; manufacturing test fundamentals, fault modeling and simulation, automatic test pattern generation algorithms; enhancing testability of digital systems; design for testability; advanced testing techniques: test data compaction and compression techniques; integrated circuits vs system-on-A-chip (SOC) design styles and their manufacturing test implications.

0418-561: SYSTEM & NETWORK SECURITY
CR: 3

This course introduces a wide range of security problems in software, systems, and networks. Main topics include principles of systems and network security; classical and modern threat models in computing systems; security in operating systems, browsers, and at the IP stack, transport layer security; defensive methods; and security analysis.

0418-562: SOFTWARE SECURITY
CR: 3

The course provides a deep insight into state-of-the-art security problems facing design, con-struction, and maintenance of software systems. Main concepts include vulnerability analysis and detection through static and dynamic analysis, information flow analysis, trusted compu-ting base, sandboxing, and return-oriented programming.

0418-563: DATA PROTECTION AND PRIVACY
CR: 3

This is an advanced graduate course that utilizes presents the theoretical foundations for priva-cy

protection in database. The course will include advanced applied theoretical topics such as homomorphism, design of encrypted databases, encrypted queries, data anonymity systems considerations, and privacy in the cloud.

0418-564: COMPUTATIONAL BIOLOGY
CR: 3

Main topics include central dogma in biology, bioinformatics databases and sequence alignment, phylogenetic trees & clustering techniques, molecular dynamics simulations and applications, hidden markov models, affine transformations and modeling molecular aggregation.

0418-565: COMPUTATIONAL MEDICINE
CR: 3

Main topics include an overview of computational medicine & medical informatics, electronic health records and health systems, designing scalable software systems for health, algorithm development for diabetes pumps, and computational molecular docking and drug design

0418-566: MACHINE LEARNING
CR: 3

The course covers the basic concepts and techniques of Machine Learning from both theoretical and practical perspective. The material includes decision trees, artificial neural networks, deep learning, Bayesian learning, instance-based learning and reinforcement learning

0418-567: ALGORITHMS FOR OPTIMIZATION
CR: 3

Methods and algorithms for developing systems and software to solve single and multiple objective optimization problems. Methods include backtracking, direct search, and gradient-based methods.

0418-580: TOPICS IN COMPUTER SCIENCE
CR: 3

Special topics not covered in other courses, May be repeated for credit under different subtitles.

0418-590: RESEARCH SEMINAR IN COMPUTER SCIENCE
CR: 1

The aim of the research seminar is to allow the M.Sc. candidate to gain experience in preparing and presenting his/her research work.

0418-593: PROJECT
CR: 3

The student undertakes an independent project on a research topic of theoretical and/or experimental focus under the supervision of a faculty member listed in the supervisory list of the College of Graduate Studies. The objective is to provide the student with an opportunity to integrate and apply the knowledge gained throughout the course of study in a practical problem. The student must document the project in a scientific report following standard research writing guidelines and give a public presentation to the project examination committee.

0418-597: THESIS
CR: 0

0418-598: THESIS
CR: 0

2000-599: THESIS
CR: 9