DEPARTMENT OF INFORMATION AND COMPUTER SCIENCE

Chairman

Dr. Khalid Al-Jasser

Faculty

Adam	Ahmad	El-Alfy
Alvi	Arafat	Aslam
El-Attar	Azzedin	Balah
El-Bassuny	Darwish	Elish
Faisal	Garout	Ghouti
Hasan	Hassine	Al-Jasser
Kamledin	Al-Khatib	Al-Khoraidly
Mahmoud	Mlaih	Al-Muhammadi
Al-Muhtaseb	Al-Mulhem	Niazi
Ramadan	Said	Sajjad
Al-Shayeb	Al-Suhaim	Al-Turki
Yazdani	Zhioua	

The Department of Information and Computer Scdience (ICS) offers graduate programs leading to the degrees of Master of Science in Computer Science, Ph.D. in Computer Science, Master of Science in Software Engineering, and Master of Science in Security and Information Assurance.

Admission Requirements

All applicants for admission to the department must satisfy the general Graduate School admission requirements. An M.S. applicant must have a B.S. in engineering or science from an institution whose undergraduate programs are comparable to those of KFUPM in both content and quality. All applicants must have a cumulative GPA of at least 3.0 out of 4. All M.S. applicants should have a satisfactory background in the following core areas of computer science: Data Structures, Computer Architecture, Algorithms, Programming Languages, Database Systems, Computer Networks, and Operating Systems. Insufficient background in any of these areas is considered a deficiency. Provisional admission may be granted to otherwise qualified students with core background deficiencies. Students with deficiencies must take the appropriate course(s) at KFUPM. Each deficiency course must be completed with a grade of B or better before a change of status to regular is realized.

MASTER OF SCIENCE IN COMPUTER SCIENCE

Degree Requirements

(a) Core Courses (15 credit hours)		Credit Hours
Algorithms and Complexity	ICS 553	3
Research Methods and Experiment Design in Computing	ICS 500	3
Theory and Design of Program. Languages	ICS 535	3
Seminar	ICS 599	0
Thesis	ICS 610	6

(a) Elective Courses (15 credit hours)		Credit Hours
Two ICS Courses in Major Area	ICS xxx	6
Three General Elective Courses	XXX xxx	9

Degree Plan

COURSE	TITLE	LT	LB	CR	COURSE	TITLE	LT	LB	CR
First Year									
ICS 553	Algorithms and Complexity	3	0	3	ICS 535	Theory and Design of Program. Languages	3	0	3
ICS xxx	Major Area Elective I	3	0	3	ICS xxx	Major Area Elective II	3	0	3
ICS 500	Res. Methods and Exp. Design in Comp.	3	0	3	XXX xxx	General Elective I	3	0	3
		9	**0**	**9**			**9**	**0**	**9**
Second Year									
XXX xxx	General Elective II	3	0	3	ICS 610	Thesis	0	0	6
XXX xxx	General Elective III	3	0	3					
ICS 599	Seminar	1	0	0					
ICS 610	Thesis	0	0	IP					
		7	**0**	**6**			**0**	**0**	**6**
Total credit hours required in Degree Program : 30									

MASTER OF SCIENCE IN SOFTWARE ENGINEERING

Degree Requirements

(a) Core Courses (15 credit hours)		Credit Hours
Software Requirements Engineering	SWE 515	3
Software Design	SWE 516	3
Software Testing and Quality Assurance	SWE 526	3
Seminar	SWE 599	0
Thesis	SWE 610	6

(a) Elective Courses (15 credit hours)		Credit Hours
Two SWE Elective Courses	SWE 5xx	6
One ICS Elective Course	ICS 5xx	3
Two Elective Courses	XXX 5xx	6

Degree Plan

COURSE	TITLE	LT	LB	CR	COURSE	TITLE	LT	LB	CR
First Year									
SWE 515	Software Requirements Engineering	3	0	3	SWE 526	Software Testing and Quality Assurance	3	0	3
SWE 516	Software Design	3	0	3	ICS 5xx	ICS Elective	3	0	3
SWE 5xx	SWE Elective I	3	0	3	XXX 5xx	Elective I	3	0	3
		9	**0**	**9**			**9**	**0**	**9**
Second Year									
SWE 5xx	SWE Elective II	3	0	3	SWE 610	Thesis	0	0	6
XXX 5xx	Elective II	3	0	3					
SWE 599	Graduate Seminar	1	0	0					
SWE 610	Thesis	0	0	IP					
		7	**0**	**6**			**0**	**0**	**6**
Total credit hours required in Degree Program : 30									

MASTER OF SCIENCE IN INFORMATION ASSURANCE AND SECURITY

Degree Requirements

(a) Core Courses (15 credit hours)		Credit Hours
Principles of Information Assurance and Security	SEC 511	3
Network Security	SEC 521	3
Data Security and Encryption	ICS 555	3
Seminar	SEC 599	0
Thesis	SEC 610	6

(a) Elective Courses (15 credit hours)		Credit Hours
Three SEC Elective Courses	SEC 5xx	9
Two Elective Courses	XXX 5xx	6

Degree Plan

COURSE	TITLE	LT	LB	CR	COURSE	TITLE	LT	LB	CR
First Year									
SEC 511	Principles of Info. Assurance and Security	3	0	3	SEC 521	Network Security	3	0	3
ICS 555	Data Security and Encryption	3	0	3	SEC 5xx	SEC Elective II	3	0	3
SEC 5xx	SEC Elective I	3	0	3	SEC 5xx	SEC Elective III	3	0	3
					SEC 599	Graduate Seminar	1	0	0
		9	**0**	**9**			**10**	**0**	**9**
Second Year									
XXX 5xx	Elective I	3	0	3	SEC 610	Thesis	0	0	6
XXX 5xx	Elective II	3	0	3					
SEC 610	Thesis	0	0	IP					
		6	**0**	**6**			**0**	**0**	**6**
Total credit hours required in Degree Program : 30									

PHD IN COMPUTER SCIENCE

Degree Requirements

(a) Core Courses (12 credit hours)		Credit Hours
Seminar	ICS 699	0
PhD Pre-Dissertation	ICS 711	3
PhD Dissertation	ICS 712	9

(b) Elective Courses (30 credit hours)		Credit Hours
Three ICS Courses in Major Area	ICS xxx	9
Three ICS Courses in Breadth Area	ICS xxx	9
One ICS Elective Course	ICS xxx	3
Three General Elective Courses	XXX xxx	9

Degree Plan

COURSE	TITLE	LT	LB	CR	COURSE	TITLE	LT	LB	CR
First Year									
ICS xxx	Major Area Elective I	3	0	3	ICS xxx	Major Area Elective II	3	0	3
ICS xxx	Breadth Area Elective I	3	0	3	ICS xxx	Breadth Area Elective III	3	0	3
ICS xxx	Breadth Area Elective II	3	0	3	ICS xxx	ICS Elective	3	0	3
		9	**0**	**9**			**9**	**0**	**9**
Second Year									
ICS xxx	Major Area Elective III	3	0	3	XXX xxx	General Elective III	3	0	3
XXX xxx	General Elective I	3	0	3	ICS 699	Seminar	1	0	0
XXX xxx	General Elective II	3	0	3	ICS 711	PhD Pre-Dissertation	0	0	3
		9	**0**	**9**			**4**	**0**	**6**
Third Year									
ICS 712	PhD Dissertation	0	0	IP	ICS 712	PhD Dissertation	0	0	9
		0	**0**	**0**			**0**	**0**	**9**
Total credit hours required in Degree Program : 42									

INFORMATION AND COMPUTER SCIENCE

ICS 500 Research Methods and Experiment Design in Computing (3-0-3)
Integrated treatment to the models and practices of experimental computer science. Topics include scientific methods applied to computing, computational problem/solution characterization, quality metrics and performance estimation of computation systems, uses of analytic and simulation models, design of experiments, interpretation and presentation of experimental results, hypothesis testing, and statistical analyses of data.
Prerequisite: STAT 319 or equivalent

ICS 531 Advanced Operating Systems (3-0-3)
Advanced concepts in operating systems design; multiprocessing model, interprocess communication; synchronization mechanisms; resource management and sharing; scheduling in multiprocessor system; Process migration; Operating system-level virtualization; Special-purpose operating systems: Real-time, Distributed and network operating systems; Distributed deadlock handelling; Distributed file system; Distributed shared memory; Replication & consistency; In addition, students will be exposed to recent developments in operating systems through research projects and papers.
Prerequisite: Consent of Instructor

ICS 535 Theory and Design of Programming Languages (3-0-3)
Fundamentals of type systems, type inference, control structures, and storage management. Formal syntax specification. Semantic specification models: axiomatic, operational and denotational. Project(s) to design a programming language.
Prerequisite: ICS 410 or equivalent

ICS 546 Multimedia Information Management (3-0-3)
Multimedia data representation and management in the context of content-based retrieval, audio, image and video data representation, Information retrieval from text. Content based retrieval of audio, image and video data, Similarity measures. Query formulation and evaluation, Multi-dimensional indexing algorithms and data structures. Multimedia compression. Multimedia data mining.
Prerequisite: Consent of Instructor

ICS 547 Digital Image Processing (3-0-3)
Continuous Image. Mathematical Characterization. Psychovisual Properties. Photometry and Colorimetry. Superposition and Convolution. Image Transforms. Linear Processing Techniques. Image Enhancement. Morphological Image Processing. Edge Detection. Image Feature Extraction. Image Segmentation. Shape Analysis.
Note: Can not be taken for credit with EE 663 or SE 662.
Prerequisite: Consent of Instructor

ICS 553 Algorithms and Complexity (3-0-3)
Computational complexity: P-space and EXP classes, Reduction, NP-complete problems, Cook's theorem, Randomized algorithms, Approximation algorithms, Branch-and-Bound, Amortized analysis; Max flow, Bipartite matching; Geometric algorithms: Convex hull, Closest pairs; Computability: Turing machines, Church-Turing thesis,

Rice's theorem, Undecidability.
Prerequisite: ICS 353 or equivalent

ICS 555 Cryptography and Data Security (3-0-3)
Mathematical principles of cryptography and data security. A detailed study of conventional and modern cryptosystems. Zero knowledge protocols. Information theory, Number theory, Group theory, Complexity Theory concepts and their applications to cryptography.
Prerequisite: Consent of Instructor

ICS 555 Data Security and Encryption (3-0-3)
Introduction to data security and cryptography, Mathematical principles of cryptography, Conventional and modern block and stream symmetric-key cryptosystems, Public-key cryptosystems, Message integrity and cryptographic hash functions, Digital signatures, Authentication, and Key exchange protocols. Several exercises and assignments on using cryptosystem and cryptanalysis tools.
Prerequisite: Graduate Standing

ICS 557 Advanced Machine Learning (3-0-3)
Linear and logistic regression. Regularization. Generalized linear models. Learning theory. Support vector machines. Kernel methods. Principal component analysis. Independent component analysis. Hidden Markov models. Random forests. Design of learning systems. Recommender systems. Online Learning. Ensemble learning models. Bootstrapping techniques.
Prerequisite: ICS 485 or Consent of Instructor

ICS 558 Introduction to Bioinformatics and Biomedicine (3-0-3)
This course offers an introduction to bioinformatics with an emphasis on biomedical aspects. Topics include bioinformatics databases, sequence alignments, protein domains, protein-protein interaction, gene expression, gene ontology, pathways, disease state analysis, and computational methods in biomedicine.
Prerequisite: Consent of Instructor

ICS 590 Special Topic in Computer Science I (3-0-3)
Advanced topics selected from current literature that deals with theoretical foundations and advances in computer science. The specific content of an offering of the course should focus on a specific area of computer science.
Prerequisite: Consent of Instructor

ICS 592 Special Topic in Computer Science II (3-0-3)
Advanced topics selected from current literature that deals with theoretical foundations and advances in computer science. The specific content of an offering of the course should focus on a specific area of computer science.
Prerequisite: Consent of Instructor

ICS 599 Seminar (1-0-0)

Graduate students are required to attend the seminars given by faculty members, visiting scholars, and fellow graduate students. Additionally, each student must give at least presentation on a timely research topic. Among other things, this course is designed to give the student an overview of research, research methodology, journals and professional societies. Graded on a Pass or Fail basis.
Prerequisite: ICS 500

ICS 606 Independent Research (0-0-3)
This course is intended to allow the student to conduct research in advanced problems in his MS research area. The faculty offering the course should submit a research plan to be approved by the Graduate Program Committee at the academic department. The student is expected to deliver a public seminar and a report on his research outcomes at the end of the course. Graded on a Pass or Fail basis.
Prerequisite: Consent of Instructor

ICS 610 Master Thesis (0-0-6)
The Student has to undertake and complete a research topic under the supervision of a faculty member in order to probe in depth a specific problem in Computer Science.
Prerequisite: ICS 599

ICS 611 Combinatorial, Approximation and Probabilistic Algorithms (3-0-3)
Representation and generation of combinatorial objects, Graph algorithms, Greedy method and the theory of matroids. Graph matching and applications. Network flows and applications. Approximation algorithms to combinatorial problems like scheduling, bin-packing, knapsack, vertex cover, TSP, clique partitioning, graph compression, Steiner problem on networks. Randomized algorithms: Monte-Carlo, Las-Vegas, algorithms, occupancy problems, randomized sorting and pattern matching, Markov chains and random walks.
Prerequisite: ICS 553 or Consent of Instructor

ICS 614 Advanced Pattern Recognition (3-0-3)
The course covers advanced topics in pattern recognition and machine learning. Recent conference and journal papers will be discussed in depth. Tentative topics: Classification and discriminant analysis, feature generation using transformations. Feature selection, data transformation and dimensionality reduction, Classifier evaluation, Kernel methods, error rate estimation techniques and perormance evaluation. Actual topics covered will depend on time available and students' interests.
Prerequisite: ICS 583 or equivalent

ICS 615 Advanced Computer Vision (3-0-3)
This course intends to provide an in-depth overview of the current state-of-the-art of computer vision by covering a set of advanced topics that are actively investigated. Recent conference and journal papers will be discussed in depth. Tentative topics: Low level vision: Image Segmentation, Stereo, Optical flow, de-noising and texture analysis; Higher level vision: Object Detection and Recognition/Pose Estimation; geometrical and 3D vision, stereo, 3D scene reconstruction, motion analysis, visual tracking, object recognition and human motion analysis, capturing and recognition.

Actual topics covered will depend on time available and students' interests.
Prerequisite: ICS 547 or Consent of Instructor

ICS 630 Distributed Systems (3-0-3)
Taxonomy of distributed systems: Client-server, cluster systems, Grid systems, P2P systems, cloud systems, volunteer-based systems. Distributed systems service models. Modeling, performance, scalability, elasticity and trust/reputation issues in distributed systems. Project(s).
Prerequisite: ICS 531 or Consent of Instructor

ICS 633 Semantics of Programming Languages (3-0-3)
Formal methods for the description of programming languages. Advanced semantics models, attribute grammar, two-level grammars, fixed-point theory of computation, Program verification techniques.
Prerequisite: ICS 535 or Consent of Instructor

ICS 654 Advanced Topics in Computer Networking (3-0-3)
This course explores recent research trends and developments in computer networks and their applications covering state-of-the-art topics and case studies.
Prerequisite: ICS 570 or equivalent

ICS 690 Special Topic in Computer Science III (3-0-3)
Advanced topics selected from current literature that deals with theoretical foundations and advances in computer science. The specific content of an offering of the course should focus on a specific area of computer science.
Prerequisite: Consent of Instructor

ICS 691 Special Topic in Computer Science IV (3-0-3)
Advanced topics selected from current literature that deals with theoretical foundations and advances in computer science. The specific content of an offering of the course should focus on a specific area of computer science.
Prerequisite: Consent of Instructor

ICS 699 Seminar (1-0-0)
Graduate students are required to attend the seminars given by faculty members, visiting scholars, and fellow graduate students. Additionally, each student must give at least presentation on a timely research topic. Among other things, this course is designed to give the student an overview of research, research methodology, journals and professional societies. Graded on a Pass or Fail basis.
Prerequisite: Graduate Standing

ICS 701 Directed Research I (3-0-3)
This course is intended to allow students to conduct research in advanced problems in their PhD area of specialization. Among other things, this course is designed to give the students an overview of research in computer science, and a familiarity with research methodology, journals and professional societies in his discipline. At the end

of the course, the student must deliver a public seminar to present his work and findings. The course is graded on a Pass or Fail basis.
Prerequisite: Consent of Instructor

ICS 702 Directed Research II (3-0-3)
This course is intended to allow students to conduct research in advanced problems in their PhD area of specialization. Among other things, this course is designed to give the students an overview of research in computer science, and a familiarity with research methodology, journals and professional societies in his discipline. At the end of the course, the student must deliver a public seminar to present his work and findings. The course is graded on a Pass or Fail basis.
Prerequisite: Consent of Instructor

ICS 711 PhD Pre-Dissertation (0-0-3)
This course enables the student to submit his PhD Dissertation Proposal and defends and defends it in public. The student passes the course if the PhD Dissertation committee accepts the submitted dissertation proposal report and upon successfully passing the Dissertation proposal public defense. The course grade can be NP, NF, or IP.
Corequisite: ICS 699
Prerequisite: PhD Candidacy

ICS 712 PhD Dissertation (0-0-9)
This course enables the student work on his PhD Dissertation as per submitted dissertation proposal, submit its final report and defend it in public. The student passes this course if the PhD Dissertation committee accepts the submitted final dissertation report and upon successfully passing the Dissertation public defense. The course grade can be NP, NF, or IP.
Prerequisite: ICS 711

SOFTWARE ENGINEERING

SWE 505 Principles of Software Engineering (3-0-3)
Software Requirements: Modern SRS for Enterprise Application, Software Process: Personal and Team Software Process, Traditional Software Processes and Agile Processes. Software Design: Architecture Tradeoff Analysis and patterns. Software Project Management: project initiation, planning, executing, monitoring control and closing. Software Engineering Measurement and Analysis, Software Quality Assurance: 6-Sigma. Software Integration: Enterprise Application Integration, COTS Integration.
Note: Can not be taken for credit by SWE students.
Prerequisite:

SWE 515 Software Requirements Engineering (3-0-3)
The course gives state of the art and state of the practice in software requirements engineering. In-depth research-oriented study of methods, tools, notations, and

validation techniques for the analysis, specification, prototyping, and maintenance of software requirements. Topics include study of object-oriented requirements modeling, using state of the art modeling techniques such as the Unified Modeling Language (UML). The course work includes a project investigating or applying approaches to requirements engineering.
Note: Can not be taken for credit with ICS 512.
Prerequisite:

SWE 516 Software Design (3-0-3)
Concepts and methods for the architectural design of large-scale software systems. Fundamental design concepts and design notations are introduced. Several design methods are presented and compared. In-depth research-oriented study of object-oriented analysis and design modeling using state of the art modeling techniques such as Unified Modeling Language (UML). Students participate in a group project on object-oriented software design.
Note: Can not be taken for credit with ICS 513.
Prerequisite:

SWE 526 Software Validation, Verification, and Quality Assurance (3-0-3)
In-depth research-oriented study of verification and validation throughout the development lifecycle. Techniques for validation and verification, quality assurance at the requirements and design phases, software testing at the unit, module, subsystem, and system levels. Automatic and manual techniques for generating and validating test data. Testing process: static vs. dynamic analysis, functional testing, inspections, and reliability assessment.
Note: Can not be taken for credit with ICS 514.
Prerequisite:

SWE 531 Secure Software (3-0-3)
Software security development lifecycle including security requirements analysis, design, coding, review, and testing. Construction of secure and safe C/Unix programs. Vulnerabilities in C source code. Stack and heap buffer overflows. Overview of secure web application development with consideration for SQL injection, cookies, and forceful browsing. Techniques for software protection, such as code obfuscation, tamper-proofing, and water-marking. Analysis of software based attacks and defenses, timing attacks and leakage of information. Type safety and capability systems.
Prerequisite:

SWE 532 Web Applications Security (3-0-3)
Study of contemporary web application vulnerabilities, based on the OWASP (Open Web Application Security Project). Study of exploitation techniques for server and client web applications, and techniques that lead to web defacement and server penetration. Auditing and scanning web applications and servers for security weaknesses and vulnerabilities. Contemporary attack scenarios exploiting web vulnerabilities such as cross-site scripting, SQL injection, cookies, and forceful browsing. Content-based attacks and effective countermeasures. Secure programming for the following technologies: .NET, ASP.NET, ActiveX, JAVA, Secure Sockets, and

XML, and a study of web security protocols such as SSL and HTTPS.
Prerequisite:

SWE 536 Software Architecture (3-0-3)
Advanced principles, methods and best practices in building software architecture and the architecture design process are discussed. Architectural styles and patterns are presented and compared. Software architecture analysis and evaluation methods such as ATAM and CBAM, tradeoffs among conflicting constraints in building high quality architecture are also discussed. Architecture documentation is also presented.
Prerequisite:

SWE 539 Software metrics (3-0-3)
Software metrics history and current practice, basics of measurement theory for software metrics, framework for software measurement, product, application, and process metrics. The course includes introduction to foundations of measurement theory, models of software engineering measurement, software products metrics, software process metrics and measuring management.
Prerequisite:

SWE 566 Software Agents (3-0-3)
Agent-based programming; elements of distributed artificial intelligence; beliefs, desires and intentions; component based technology; languages for agent implementations; interface agents; information sharing and coordination; KIF; collaboration; communication; ontologies; KQML; autonomy; adaptability; security issues; mobility; standards; agent design issues and frameworks; applications in telecommunications.
Prerequisite: Consent of Instructor

SWE 585 Empirical software engineering (3-0-3)
The course discusses how empirical studies are carried out in software engineering. The distinction between analytical techniques and empirical techniques is reviewed. Other topics include empirical studies required in software engineering, kinds of problems that can be solved empirically, methods used to control variables and eliminate bias in empirical studies, and analysis and presentation of empirical data for decision making.
Prerequisite:

SWE 587 Software Project Management (3-0-3)
Lifecycle and process models; process metrics; planning for a software project; mechanisms for monitoring and controlling schedule, budget, quality, and productivity; and leadership, motivation, and team building. Topics cover quantitative models of the software lifecycle, process improvement techniques, cost-effectiveness analysis in software engineering, multiple-goal decision analysis, uncertainty and risk analysis, software cost estimation, software engineering metrics; and quantitative lifecycle management techniques.
Note: Can not be taken for credit with ICS 515.

Prerequisite:

SWE 588 Global Software Development (3-0-3)
Evolution of software development, Essentials of global software development, Software development outsourcing, Global software project management concepts, tools, and techniques, Emerging topics in global software development, Cross-cultural collaboration, Global project leadership, Measuring organizations readiness for global software development, Software quality in global software development (CMMI, ISO 9001:2000), Global software development challenges, and Professional practices for global software development (i.e., copyright, intellectual property rights etc).
Prerequisite: Graduate Standing or Consent of Instructor

SWE 595 Special Topics in Software Engineering (3-0-3)
Advanced topics selected from current journals of software engineering that deal with theoretical development or applications in the field. Topic include: Reusable Software Architectures, Software Engineering, Experimentation, Concurrent Software Systems, Software Metrics, Web Engineering or Formal Methods and Models in Software Engineering, etc.
Prerequisite: Consent of Instructor

SWE 599 Seminar (1-0-0)
Graduate students are required to attend the seminars given by faculty members, visiting scholars, and fellow graduate students. Additionally, each student must give at least presentation on a timely research topic. Among other things, this course is designed to give the student an overview of research, research methodology, journals and professional societies. Graded on a Pass or Fail basis.
Prerequisite: Graduate Standing

SWE 606 Independent Research (3-0-3)
This course is intended to allow the student to conduct research in advanced problems in his MS research area. The faculty offering the course should submit a research plan to be approved by the Graduate Program Committee at the academic department. The student is expected to deliver a public seminar and a report on his research outcomes at the end of the course. Graded on a Pass or Fail basis.
Prerequisite: Prior arrangement with an instructor

SWE 610 MS Thesis (0-0-6)
The student has to undertake and complete a research topic under the supervision of a faculty member in order to probe in depth a specific problem in Computer Science.
Prerequisite: SWE 599 or Consent of Instructor

SWE 634 Real-Time and Distributed Software with Reusable Components (3-0-3)
Advanced object-oriented design and programming of real-time and distributed systems using C++ and/or Java. Object-oriented features: inheritance, polymorphism, templates, exception handling and Concurrency issues. Design patterns and

frameworks for distributed systems, with examples from communication applications. Design issues for reusable software.
Prerequisite: Consent of Instructor

SWE 634 Software Reuse (3-0-3)
In-depth research based study of the concepts and engineering principles of software reuse with a focus on component-based reuse, domain analysis and modeling, service-oriented architectures; quality aspects of reuse, economic models of reuse; and reuse of non-code artifacts.
Prerequisite: Consent of Instructor

SWE 638 Software Maintenance and Re-Engineering (3-0-3)
Software evolution and reengineering approaches and abstraction techniques to extract specifications and design from existing code are discussed. Major maintenance activities are presented including estimating maintenance costs, managing change and predicting maintainability with software quality metrics. Organizational issues relative to product maintenance are discussed. Principles of reverse engineering techniques are also presented.
Prerequisite: Consent of Instructor

SWE 670 Formal Methods and Models in Software Engineering (3-0-3)
In-depth advanced formal mechanisms for specifying, validating, and verifying software systems. Program verification. Formal specification via algebraic specifications and abstract model specifications, including initial specification and refinement toward implementation. Integration of formal methods with existing programming languages, and the application of formal methods to requirements analysis, testing, safety analysis, and object-oriented approaches. Model-driven architectures. Formal methods using the Object Constraint Language (OCL).
Prerequisite: Consent of Instructor

SWE 671 Global Software Engineering (3-0-3)
Topics include: Essentials of global software engineering, Software engineering outsourcing (Onshore outsourcing, Nearshore Outsourcing, Offshore outsourcing), Outsourcing models (Simple Dyadic Outsourcing, Multi-Vendors Outsourcing, Co-Sourcing and Complex Outsourcing), Global software project management concepts, tools, and techniques, Managing virtual teams, Cross- cultural collaboration, Global project leadership, Measuring organizations readiness for global software development, Software quality in global software development (CMMI, ISO 9001:2000), Global software engineering challenges, Professional practices for global software engineering (Intellectual Property Rights, Group working, conflict and negotiations management, Presentations, writing and referencing).
Prerequisite: Consent of Instructor

INFORMATION ASSURANCE & SECURITY

SEC 511 Principles of Information Assurance and Security (3-0-3)
Introduction to information Assurance & Security. Information confidentiality, availability, protection, and integrity. Security systems lifecycle. Risks, attacks, and the need for security. Legal, ethical, and professional issues in information security. Risk management including identification and assessment. Security technologies and tools. Security laws, audit and control. Cryptography foundations, algorithms and applications. Physical security, security and personnel, security implementation and management. Securing critical infrastructure. Trust and security in collaborative environments.
Prerequisite: Graduate Standing

SEC 521 Network Security (3-0-3)
Network infrastructure security issues, including perimeter security defences, firewalls, virtual private networks, intrusion detection systems, wireless security, and network security auditing tools. Secure network applications. Network security protocols such as SSL, SSL/TLS, SSH, Kerberos, IPSec, IKE. Network threats and countermeasures. Network auditing and scanning. VoIP Security. Remote exploitation and penetration techniques. Network support for securing critical infrastructure. Design and development of software-based network security modules and tools based on hands-on experiences and state-of-the-art technologies.
Note: Can not be taken for credit with CSE 551
Prerequisite: ICS 555

SEC 524 Computer and Network Forensics (3-0-3)
Methodical approaches for collecting and preserving evidence of computer crimes, laws/regulation, and industry standards. Hands-on experience on identifying, analyzing, recreating, and addressing cyber based crimes. Ethical issues associated with information systems security. Foundational concepts such as file system structures, MAC times, and network protocols. Use of tools for evidence recovery. Use of established forensic methods in the handling of electronic evidence. Rigorous audit/logging and date archival practices. Prevention, detection, apprehension, and prosecution of security violators and cyber criminals, and general legal issues.
Prerequisite: SEC 521

SEC 528 Security in Wireless Networks (3-0-3)
Security of wireless networks such as cellular networks, wireless LANs, mobile ad hoc networks, wireless mesh networks, and sensor networks. Overview of wireless networks. Study of threats and types of attacks, including attacks on MAC protocols. Selfish and malicious behavior in wireless routing protocols. Countermeasures/solutions and their limitations. Encryption and authentication. Secure hand-off techniques. Energy-aware security mechanisms. Secure multicasting. Key pre-distribution and management in wireless networks.
Prerequisite: SEC 521

SEC 534 Database Security (3-0-3)
Study of database security and auditing issues, challenges and protection methods. A review of relational and object database concepts. Database security and auditing

issues. Authentication methods. Authorization based on privileges, roles, profiles, and resource limitations, and role-based authorization constraints. A study of access control mechanisms for current DBMSs, content-based and fine-grained access control, access control systems for object-based design and XML. Data confidentiality and privacy for databases. Secure statistical databases. Integrating databases and applications security. Database security protection via inference detection. Security implementation and administration, with applications to ecommerce, and emerging research in database security.
Prerequisite: SEC 511

SEC 536 Web Application Security (3-0-3)
Web applications security requirements, threats and countermeasures. Contemporary web application vulnerabilities and exploitation techniques, based on the Open Web Application Security Project (OWASP). Web defacement and server penetration techniques. Content-based attacks and effective countermeasures. Intellectual property protection and watermarking. Auditing and scanning Web applications and infrastructure for security weaknesses. Analysis of Web applications for key vulnerabilities and attacks. Security mechanisms and protocols and their roles in securing Web applications. Secure Web programming mechanisms in ASP.NET, Java, PHP, XML and SQL. Secure Web applications for e-commerce, e-banking and e-government transactions. Numerous hands-on exercises and projects on using tools and writing secure Web applications.
Prerequisite: SEC 511

SEC 538 Trusted Computing (3-0-3)
A comprehensive overview of trusted computing technology and its applications, TPM chips, secure boot, attestation, DRM, sealed storage, nature of trust, methods for characterizing, establishing, and attesting trust of a system. Trusted Virtualization. Operating system and hardware support for TC. Key management. Code signing. Identity management. Implications of certification. Trusted Mobile Platforms. Trust negotiation, transitive trust, trust evaluation and reputation systems. Trust computing architectures and modeling. Trust computing in P2P and cloud computing paradigms. Design and development of software applications and components to utilize trust computing for protecting information providers and end users.
Prerequisite: SEC 511, ICS 555

SEC 544 Biometric Systems (3-0-3)
Theory of signal processing, especially image and sound processing, for purposes of biometric system design. An introduction to basic methods and techniques for the study of authentication based on static biometric features such as fingerprints, hand geometry, facial features, thermograms, iris and retina, voice, and handwriting. Study of recognition based on dynamic features including lip movements, typing, and gait, study of standards and applications of biometry.
Prerequisite: Graduate Standing

SEC 546 Embedded Systems Security (3-0-3)
Study of various security models and techniques for embedded systems both from a

hardware as well as a software perspective. Smart card security. RFID attack models (including power analysis, side channel, and timing attacks), and security techniques. Security in wireless sensor networks (key management techniques, attack models, detection and prevention techniques). eHealth (embedded medical systems) security. Cryptographic hardware. Industrial control systems (SCADA). Physical hardware. Security for System-on-chip, and Internet-devices such as Internet thermostats and automated doors.
Prerequisite: Graduate Standing

SEC 548 Watermarking and Steganography (3-0-3)
Study of enabling technologies for digital watermarking and steganography including the history of information hiding, basic principles and techniques such as still images, video, and 3-D video objects, and their applicability to owner authentication, content authentication, information embedding and communication with side information. Evaluation and benchmarking of watermarking and steganography mechanisms. Study of malicious attacks inclusive of bit rate limitation, counterfeiting marks and removal attacks. Overview of attempts to formalize watermarking. Steganography vs. watermarking. Applications of steganography. software for steganography, and steganalysis techniques.
Prerequisite: Graduate Standing

SEC 595 Special Topics in Information Assurance and Security (3-0-3)
Advanced topics selected from current journals of Information Assurance & Security and that deal with theoretical development or applications in the field.
Prerequisite: Graduate Standing

SEC 599 Graduate Seminar (1-0-0)
Graduate students are required to attend seminars given by faculty members, visiting scholars, and fellow graduate students. Additionally, each student must deliver at least one presentation on a contemporary research topic. Among other things, this course is designed to give the student an overview of how to conduct research, research methodology, journal specifications and submission requirements, and on professional societies. The course grade is a Pass or Fail.
Prerequisite: Graduate Standing

SEC 606 Independent Research (3-0-3)
This course is intended to allow the student to conduct research on advanced topics in his area of research for his Master degree. The faculty offering the course should submit a research plan to be approved by the graduate program committee of the ICS Department. The student is expected to deliver a public seminar and a report on his research outcomes at the end of the course.
Prerequisite: Graduate Standing

SEC 610 Master Thesis (0-0-6)
The student has to undertake research at an in-depth level under the supervision of a faculty member for a specific problem in the area of Information Assurance &

Security.
Prerequisite: SEC 599

SEC 611 Cryptographic Computations (3-0-3)
Review of number theory, set algebra and finite fields. Computations in finite fields using standard and non-standard bases. High performance algorithms and architectures for cryptographic applications. Side channel analysis attack resistant computations.
Prerequisite: ICS 555

SEC 621 Advanced Network Security (3-0-3)
Intrusion detection and prevention systems. Security engineering processes. Advanced firewall considerations. Honeynets. Network forensics. Distributed denial of service attacks (Botnet, Rootkits, Zero-Day Exploits). Cyber crime and cyber war. Enterprise security policy development. Complex enterprise security infrastructure design and integration. Web and email security. P2P network security, and trust management.
Prerequisite: SEC 521

SEC 631 Security in Operating Systems and Cloud Computing (3-0-3)
Advanced security research topics in operating systems and emerging computing paradigm such as grid and cloud computing. Secure operating system requirements, fundamentals and definitions. Security in traditional and popular operating systems such as Unix, Linux, OpenBS,D and Windows. Security kernels. Verifiable security goals, trusted processes, and information flow integrity. Secure capability systems. Security in virtualization and secure virtual machine systems. Security issues and countermeasures in cloud computing. Data security and storage in the Cloud. Security management in the cloud services: PaaS, SaaS, and IaaS. Case Studies of secure systems, design, and evaluation: SELinux and Solaris.
Prerequisite: SEC 521