MASTER OF SCIENCE
APPLIED COMPUTER SCIENCE AND SOCIETY (ACS)

Updated April 20, 2021

Graduate Program Chair: S. Camorlinga; **Professors**: S. Liao, S. Ramanna; **Associate Professors**: S. Camorlinga; C. Henry
Assistant Professor: T. Halabi; Administrative Supervisor of Grad Students: Connie Arnhold

DEGREES/PROGRAMS OFFERED M.Sc.
The department offers a Master's program at the graduate level in **Applied Computer Science and Society** with a focus on issues of technology and ethical/human/social aspects of computing. We offer courses in three core clusters that represent frontiers of the discipline. These are: i) *Information Representation, ii) Search and Management, Intelligent Systems,* and iii) *Systems Development.*

AREAS OF RESEARCH
The research interests of our faculty include: algorithms and complexity, cloud computing, computational intelligence, computer vision, data warehousing, web and document databases, granular computing, health informatics, image processing, machine learning, parallel processing, pattern recognition, rough sets, software engineering, security and privacy, and advanced research computing. Information about specific research topics can be found on the faculty web pages
https:// www.acs.uwinnipeg.ca

We offer both thesis-based and course programs. Our thesis-based program is designed to provide an excellent basis for a Ph.D. in computer science or other related fields. Our graduates in the course-based program are well-qualified for employment in industry, the public-sector, and academia.

REQUIREMENTS FOR A M.Sc. IN
APPLIED COMPUTER SCIENCE AND SOCIETY
(Thesis-Based)

ADMISSION REQUIREMENT
Students may be admitted to the thesis-based Master's program if they hold an Honours or 4-year Bachelor of Science degree in Applied Computer Science, Computer Science and/or Engineering, Mathematics or equivalent and if they present a suitable selection of courses. A student must have a supervisor selection prior to admission.

- Minimum entry requirement: overall GPA of 3.0.
- English requirement: A minimum TOEFL score of 550 (paper-based), 213 (computer-based), 80 (Internet-based) or International English Language Testing System **IELTS** (6.5) is needed. The test should have been taken within two years of the date a completed application is filed.

Students can also be admitted to the Master's program upon successful completion of a University of Winnipeg designed pre-Master's program which consists of a set of upper-level undergraduate courses. Please contact the Department for details.

APPLICATION DEADLINES
The Department allows students to begin their program in September or January. For admission for each of these start dates, Canadian/U.S. students should send their applications with complete supporting documentation to the Office of Graduate Studies no less than three (3) months before the intended start date. All other students should send their applications with complete supporting documentation no later than six months (6) before the intended start date. Application form can be downloaded from
http://www.uwinnipeg.ca/index/grad-studies-programs

PROGRAM REQUIREMENTS
Students are required to take **a minimum of** 12 credit hours from the list of Applied Computer Science Graduate courses, plus GACS-7500 Graduate Thesis. Students are required to write a thesis and successfully defend their thesis in an open oral defense in the presence of a thesis committee. Students must select their courses in consultation with their thesis supervisor.

SECOND LANGUAGE REQUIREMENT: None
EXPECTED TIME TO GRADUATE: 2 years
MAXIMUM TIME REQUIRED TO GRADUATE: 5 years

REQUIRED COURSES
- Minimum **12 credits** from the Applied Computer Science Graduate courses
- **GACS-7500 GRADUATE THESIS**

REQUIREMENTS FOR A M.Sc. IN APPLIED COMPUTER SCIENCE AND SOCIETY (Course-Based)

ADMISSION REQUIREMENT

Students may be admitted to the course-based Master's program if they hold an Honours or 4-year Bachelor of Science degree in Applied Computer Science, Computer Science and/or Engineering, Mathematics or equivalent and if they present a suitable selection of courses.

- Minimum entry requirement: overall GPA of 3.0 in all computing, mathematics and statistics courses.
- English requirement: A minimum TOEFL score of 550 (paper-based), 213 (computer-based), 80 (Internet-based) or International English Language Testing System **IELTS** (6.5) is needed.
  The test should have been taken within two years of the date a completed application is filed.

APPLICATION DEADLINES
The Department allows students to begin their program in September or January. For admission for each of these start dates, Canadian/U.S. students should send their applications with complete supporting documentation to the Office of Graduate Studies no less than three (3) months before the intended start date. All other students should send their applications with complete supporting documentation no later than six months (6) before the intended start date. Application form can be downloaded from http://www.uwinnipeg.ca/index/grad-studies-programs

PROGRAM REQUIREMENTS

Students are required to take
- **a minimum of** 21 credit hours of GACS-7xxx/3 courses (excluding GACS-7500 thesis course)
- **a minimum of** 9 credit hours of ACS-4xxx/3 courses

SECOND LANGUAGE REQUIREMENT: None
EXPECTED TIME TO GRADUATE: 2 years
MAXIMUM TIME REQUIRED TO GRADUATE: 5 years

SWITCHING from Course-based Program to Thesis-based Program:
Students may switch from *course-based to thesis-based at any time during the* program provided a thesis supervisor is willing to accept them. The department is not responsible for finding thesis supervisors.

SWITCHING from Thesis-based to Course-based Program:
Students may switch from *thesis-based to course-based program after the first term* from the date of registration. A switch can be made only with the written approval of their thesis Supervisor and the Graduate Program Committee Chair.

Applied Computer Science Department Courses

Information Representation, Search and Management Cluster:
- **GACS-7101/3** ADVANCED DATA STRUCTURES AND ALGORITHMS FOR APPLIED COMPUTER SCIENCE
- **GACS-7102/3** WEB AND DOCUMENT DATABASES
- **GACS-7103/3** SEMANTIC WEB
- **GACS-7104/3** THEORY AND PRACTICE OF SECURITY AND PRIVACY
- **GACS-7105/3** OPERATIONS RESEARCH IN COMPUTER SCIENCE

Intelligent Systems Cluster:
- **GACS-7201/3** BIOMETRICS
- **GACS-7202/3** GRANULAR COMPUTING: FOUNDATIONS AND APPLICATIONS
- **GACS-7203/3** PATTERN RECOGNITION
- **GACS-7204/3** MULTIMEDIA COMPUTING AND APPLICATIONS
- **GACS-7205/3** DIGITAL IMAGE PROCESSING
- **GACS-7206/3** ADVANCED MACHINE LEARNING

Systems Development Cluster:
- **GACS-7301/3** IMPLEMENTATION AND IMPACT OF PEER-TO-PEER SYSTEMS
- **GACS-7302/3** GLOBAL SOFTWARE PROJECT MANAGEMENT
- **GACS-7303/3** ADVANCED TOPICS IN SOFTWARE DESIGN AND ARCHITECTURE
- **GACS-7304/3** COMPUTER SYSTEMS FOR SOCIETY
- **GACS-7305/3** GRADUATE PROJECT
- **GACS-7306/3** APPLIED PARALLEL PROGRAMMING
- **GACS-7307/3** ADVANCED CONCEPTS IN CLOUD COMPUTING

Topics: - GACS-7401/3 CURRENT TOPICS IN COMPUTING

Thesis: - GACS-7500 GRADUATE THESIS

COURSE DESCRIPTIONS

Information Representation, Search and Management Cluster:

GACS-7101(3) ADVANCED DATA STRUCTURES AND ALGORITHMS FOR APPLIED COMPUTER SCIENCE (Le3) In this course, students will study methods for designing efficient data structures and algorithms such as binary search trees, red-black trees, priority queues, minimum spanning trees, strongly connected components, maximum flows, string matching and tree matching, bipartite graphs, as well as the algorithm analysis and proof. Through the study of these data structures and algorithms, students will develop skills to solve hard problems in specialized databases such as Graph databases, DNA and Deductive databases.
PREREQUISITES: Consent of the Department Graduate Program Committee Chair or Instructor.

GACS-7102(3) WEB AND DOCUMENT DATABASES (Le3) In this course, students will gain a good understanding and knowledge of research issues associated with two types and databases. In particular, students will study basic theoretic issues of web and document databases: system architectures, XML data storage and data compression, data retrieval and twig matching, data stream system, as well as the search engine architecture. Another specific methodology related to Graph databases will also be discussed.
PREREQUISITES: Consent of the Department Graduate Program Committee Chair or Instructor.

GACS-7103(3) SEMANTIC WEB (Le3) This course examines current issues related to the next generation of the World Wide Web: the Semantic Web that is intended to convert the Web into a more practical globally linked database. Topics comprise document markup languages, access privileges, business rules, and processing models for managing data. A typical project involves the design and implementation of an application for managing semi-structured data using XML technologies.
PREREQUISITES: Consent of the Department Graduate Program Committee Chair or Instructor.

GACS-7104(3) THEORY AND PRACTICE OF SECURITY AND PRIVACY (Le3) This course provides students an understanding of theoretical and practical aspects of security and privacy and opens them up to the current research challenges in this area. Topics include classical cryptography, symmetric encryption, public key cryptography, key distribution mechanisms, digital signature, entity and message authentication, access control, multimedia security and digital right management, secret sharing, physical security, privacy preserving techniques such as data aggregation, perturbation, *k*-anonymity and *l*-diversity.
PREREQUISITES: Consent of the Department Graduate Program Committee Chair or Instructor.

GACS-7105(3) OPERATIONS RESEARCH IN COMPUTER SCIENCE (Le3) This course provides a broad focus on algorithmic and practical implementation of Operations Research (OR) techniques, using theory, applications, and computations to teach students the basics of both deterministic and probabilistic decision making. It introduces linear programming and emphasizes its underlying mathematical structures, algorithms, and solutions of practical programs. Topics covered include: formulations and relaxations, the geometry of linear optimization, convexity analysis, duality theory, the simplex method, sensitivity analysis, constrained and unconstrained optimization methods, robust optimization, network flows, semidefinite optimization, nonlinear optimization, heuristic programming, game and decision theory, Markov chains and queuing systems. At the end of the course, students will be able to solve real world problems using optimization software tools.
PREREQUISITES: Consent of the Department Graduate Program Committee Chair or Instructor.

Intelligent Systems Cluster:

GACS-7201(3) BIOMETRICS (Le3) Biometrics refers to the automatic identification of a person based on his/her physiological or behavioral characteristics. With the increased integration of computers and Internet into our everyday lives, to protect sensitive and personal data becomes more important and challenging. This course focuses on the design of various biometric systems based on fingerprints, voice, face, hand geometry, palm print, iris, retina, and other modalities. Multimodal biometric systems that use two or more of the above characteristics are studied. This course also examines biometric system performance and the issues related to the security and privacy aspects of these systems.
PREREQUISITES: Consent of the Department Graduate Program Committee Chair or Instructor.

GACS-7202(3) GRANULAR COMPUTING: FOUNDATIONS AND APPLICATIONS (Le3) This course examines granular computing as a framework of theories, methodologies, techniques, and tools that make use of information granules in the process of problem solving. Granular computing has a significant impact on the design and implementation of intelligent systems. Emphasis is placed on the study of the theory of rough and fuzzy sets. Applications of these theories are also explored. This course also examines social issues that arise from application of these theories in selected domains.
PREREQUISITES: Consent of the Department Graduate Program Committee Chair or Instructor.

GACS-7203(3) PATTERN RECOGNITION (Le3) This course gives students an overview of classification techniques. It covers methods from linear classifiers to nonparametric techniques. Feature generation, selection, and extraction techniques are examined. Both supervised and unsupervised learning methods are discussed.
PREREQUISITES: Consent of the Department Graduate Program Committee Chair or Instructor.

GACS-7204(3) MULTIMEDIA COMPUTING AND APPLICATIONS (Le3) This course provides graduate students with an in-depth knowledge of various computational techniques and tools used in multimedia research (images, videos, speech, graphics and documents). The course covers the following topics: fundamentals of multimedia signal processing, multimedia compression, wireless multimedia, multimedia summarization, content-based multimedia retrieval, multimedia surveillance and security, and current issues and trends in multimedia research. The objective of this course is to prepare students to understand the theoretical foundation of multimedia computing, and to apply computational tools such as Matlab, Intel OpenCV, etc., to the processing and analysis of multimedia data.
PREREQUISITES: Consent of the Department Graduate Program Committee Chair or Instructor.

GACS-7205(3) DIGITAL IMAGE PROCESSING (Le3) This course provides students a detailed overview of Digital Image Processing and its applications. Image processing

has found applications in many areas from medical imaging to computer graphics. This course covers the fundamental concepts of visual perception and image acquisition, basic techniques of image manipulation, segmentation and coding, and a preliminary understanding of Computer Vision. With successful completion of the course, students will be able to perform image manipulations and analysis in many different fields.
PREREQUISITES: Consent of the Department Graduate Program Committee Chair or Instructor.

GACS-7206(3) ADVANCED MACHINE LEARNING (Le3) The course covers core machine algorithms, but emphasis is placed on research-level machine learning methods and theory. Algorithms for classification, clustering, regression and dimensionality reduction are covered. Discovering patterns in web content, structure and usage are to be discussed. Applications of these algorithms for effectively using machine learning methods to solve real-world problems are explored via the Weka machine learning workbench. Evaluating predictive quality of the algorithms and assessing credibility of learned patterns with statistical methods are covered.
PREREQUISITES: Consent of the Department Graduate Program Committee Chair or Instructor.

Systems Development Cluster:

GACS-7301(3) IMPLEMENTATION AND IMPACT OF PEER-TO-PEER SYSTEMS (Le3) The course is divided into two parts. First half of the course examines the foundations, implementation, and characteristics of various peer-to-peer systems (both research and production). Topics discussed will include the formation, structure, maintenance, purpose, and function of peer-to-peer systems, as well as their commonalities and differences. The second half of the course examines the social issues that arise from the manner in which peer-to-peer systems are structured and used. The issues examined in this half include: copyright-related issues such as the Napster and Grokster decisions; anonymity and privacy, with respect to systems such as Tor; and security-related issues.
PREREQUISITES: Consent of the Department Graduate Program Committee Chair or Instructor.

GACS-7302(3) GLOBAL SOFTWARE PROJECT MANAGEMENT (Le3) This course identifies and addresses the social, organizational and technical issues in managing global software projects. Its topics include communications and coordination in a distributed environment; critical success factors; global project management framework; generic design (void of nationalities) and local design (with target culture); and evaluation criteria of the perceived effectiveness of various global project management strategies. The course incorporates both theory and practice, including case studies from international software development companies. Students are expected to participate in research to enrich the course material.
PREREQUISITES: Consent of the Department Graduate Program Committee Chair or Instructor.

GACS-7303(3) ADVANCED TOPICS IN SOFTWARE DESIGN AND ARCHITECTURE (Le3) This course considers problems and issues in the development of enterprise-level software systems. Topics may include software architectures, model driven development, development methodologies, design patterns, frameworks, coding practices, etc. During the semester students are required to work on the design and/or implementation of a complex multi-tiered system.
PREREQUISITES: Consent of the Department Graduate Program Committee Chair or Instructor.

GACS-7304(3) COMPUTER SYSTEMS FOR SOCIETY (Le3) This course provides students a broad understanding of how the computer systems are used in various societal domains such as human communication, education, homeland security, health and medicine, government, business, and transportation. The focus of the course is on study of the frameworks, models and algorithms used in these systems and on to expose students with the areas where improvement can be done. Students are required to undertake a course-end project to identify the potential research problems in a particular application area and investigate their innovative scientific solutions in order to have a greater impact on society.
PREREQUISITES: Consent of the Department Graduate Program Committee Chair or Instructor.

GACS-7305(6) GRADUATE PROJECT (P)
The intent of this course is to allow a student to choose an area of specialization and to work on a state-of-the-art project in that area. Suitable projects may include, for example, the implementation and evaluation of new algorithms or the use of modern technologies for novel applications. Completion of the course requires a written report and an oral presentation. The specific details of the report are determined in consultation with the project advisor, but must include a survey of relevant literature, a description and evaluation pertinent to the student's work, and details of software authored by the student.
PREREQUISITES: Consent of the Department Graduate Studies Program Committee Chair or Instructor.
RESTRICTIONS: Open only to course-based stream students.
RESTRICTIONS : Students must complete two semesters in the ACS graduate program before they can take the project course.

GACS-7306(3) APPLIED PARALLEL PROGRAMMING (Le3) The course focuses on parallel and distributed computing in high-performance scientific application, using the parallel execution model, a generalization of the traditional single threaded paradigm. The course covers knowledge of multi-core processors, concurrency, parallel execution, latency, communication and coordination among processes, message passing, shared-memory models, optimization techniques, parallel algorithms, decomposition strategies, system architecture, and performance analysis and tuning. Using the language C/C++, students gain hands-on experience writing scalable parallel applications for Graphics Processing Units.
PREREQUISITES: Consent of the Department Graduate Program Committee Chair or Instructor.
RESTRICTIONS: (ineligible students): Students who have taken ACS-4306 will not be eligible to take GACS-7306 for ACS degree credit.

GACS-7307 ADVANCED CONCEPTS IN CLOUD COMPUTING (Le3) This course provides extensive coverage of major subjects in Cloud Computing. It gives an overview of Cloud Computing and explains its main service delivery models, deployment architectures, and key enabling technologies such as virtualization, parallel computing, and BigData analytics. Students will acquire considerable knowledge in Cloud data and resource management, design patterns, security and privacy challenges and solutions, as well as commercial and open-source Cloud systems. Other topics covered include application migration to the Cloud, interoperability issues, Quality of Service and Service Level Agreement. Students will also gain critical research skills by taking on a research project in Cloud Computing.
PREREQUISITES: Consent of the Department Graduate Program Committee Chair or Instructor.

GACS-7401(3) CURRENT TOPICS IN COMPUTING (Le3)
This course is a combination of readings, discussions, hands-on projects, and oral presentations that explore current topics in the field of computer science. During the semester students may be required to work on the design and/or implementation of systems, participate in discussions, and present seminars on chosen topics.
PREREQUISITES: Consent of the Department Graduate Program Committee Chair or Instructor.

GACS-7500(3) GRADUATE THESIS (P) Graduate thesis research. Detailed exploration of an area of Applied Computer Science chosen for thesis research.
PREREQUISITES: Consent of the Department Graduate Program Committee Chair or Instructor.