Computer Science and Engineering - Graduate Programs

Objective

The purpose of the graduate programs in Computer Science (CS) and Computer Engineering (CpE) is to facilitate the student's continued professional and scholarly development. The Master of Science (M.S.) programs are designed to extend the student's knowledge and emphasize a particular area of concentration. The Master of Software Engineering (SwE.) program is designed to provide the student with the opportunity for professional development in the software engineering field. Students who have completed a bachelor's degree in CS, CpE or closely related fields wishing to pursue a doctoral degree may apply for admission in the B.S. to Ph.D. track. The admission requirements to this highly competitive track are the same as those for "advanced admission" (see B.S. to Ph.D. Accelerated Programs). The Doctor of Philosophy (Ph.D.) programs are designed to prepare the student to conduct research and development in an area of concentration.

Areas of study include

a. **Systems and Architecture:** parallel processing, cloud computing, distributed systems, scheduling and load balancing, computer architecture, tools for parallel programming, performance evaluation, fault-tolerant computing, real-time systems, RISC processor design, microprocessor systems
b. **Embedded Systems:** microcontrollers, system-on-chip, and FPGA devices, real-time operating systems, data and wireless communications, IoT, real-time control, sensor fusion, edge computing
c. **Intelligent Systems and Robotics:** machine learning, robotics, pattern recognition, multi-agent environments, assistive technologies, human-centered computing, decision support, health informatics, bioinformatics
d. **Software Engineering:** software life cycles, agile methodologies, formal specifications, object-oriented software engineering, design methodologies, software testing, software evolution, software re-engineering, software processes
e. **Database and Data Analysis:** spatio-temporal data, data mining, big data analysis, database models and languages, indexing and hashing techniques, conceptual modeling, data security, query optimization, user interfaces, ontologies, Web search and ranking, social networks
f. **Networking and Security:** sensor networks, wireless networks, information security, secure programming, mobile and distributed computing, multimedia systems, pervasive computing, networking architectures

For a complete list of graduate programs and disciplines please refer to the department website (https://www.uta.edu/academics/schools-colleges/engineering/academics/departments/cse/graduate-certificates/).

Admission

The CSE graduate admission committee bases its decision for M.S. graduate admission on the following criteria (in no specific order):

- An undergraduate degree, preferably in an area related to computer science, computer engineering, or software engineering.
- An overall GPA of 3.0 or higher in undergraduate coursework.
- A 3.2 grade point average (on a 4.0 scale) on the last two years of undergraduate coursework. In particular, performance on Computer Science/Computer Engineering/Software Engineering related courses are emphasized.
- Relevance of the student’s degree (background) to the CSE curriculum.
- Rigor of the student’s Bachelor’s degree. A three-year degree is not considered rigorous. Note: International applicants with a “3+2” Master’s degree will be evaluated as equivalent to a 4-year Bachelor’s degree.
- Reputation of the University/College from which the student has received his/her previous degrees.
- A sum of verbal plus quantitative scores of at least 305 on the GRE. Additionally:
  - GRE quantitative score of at least 160
  - GRE verbal score of at least 145
  - The department does not require the advanced computer science test. A passing score on the Engineering in-Training (EIT) exam is also given consideration for admission decisions.
- Students may be accepted with a GRE score of 300, but may be required to complete additional coursework for their MS degree (see degree requirements found later in this document). In this case:
  - GRE quantitative score of at least 155
  - GRE verbal score of at least 145
- Students may also be accepted with up to three deficiency courses, but may be required to do additional coursework for their MS degree (see degree requirements found later in this document).
- International Applicants will need to take the Test of English as a Foreign Language (TOEFL) and score at least 83 with no area score of less than 20, or take the International English Language Testing System (IELTS) and score at least 6.5 in all areas.

Note: Applications with significant mathematics deficiencies may be deferred/denied pending completion of the required courses.

Note: We neither require nor review letters of recommendation or a statements of purpose from MS applicants.

Note: Students with (or completing in the near future) a BS awarded by the CSE department at UTA or a comparable degree from another accredited U.S. university who have a GPA of at least 3.2 should contact the graduate advisor regarding a GRE waiver. UTA CSE students with a GPA of at least 3.5 should contact the graduate advisor regarding nomination for Advanced Admission (i.e. admission without application and fee). Baseline criteria for GRE waiver and Advanced Admission are established by the Graduate Dean and can be found in the current version of the UTA Graduate Catalog.

The above criteria are used as follows in relevance to the three possible admission decisions, i.e., *Unconditional Status*; *Probationary Status*; and *Denied*.

- *Unconditional Status:* Applies to an applicant who meets the first six criteria above to a degree satisfactory to the graduate admissions committee.
- *Probationary Status:* Applies to an applicant who meets at least five of the six criteria to a degree satisfactory to the graduate admissions committee and whose record shows promise for success in the program or to an applicant who does not fulfill all the deficiency course requirements.
- *Denied:*Applies to an applicant who does not meet five of the first six criteria to a degree satisfactory to the graduate admissions committee.

Waiver of Graduate Record Examination

Upon recommendation of the Graduate Advisor, outstanding UT Arlington graduates may qualify for waiver of the requirements for the Graduate Record Examination (GRE). To qualify, the applicant must meet the following minimum requirements:

- The student must have graduated from a commensurate bachelor's degree program at UT Arlington no more than three academic years prior to admission to the graduate program (as measured from the start of the semester for which admission is sought). A commensurate bachelor's degree program is one that is a normal feeder program for the master's degree program to which the student seeks admission. Undergraduate students in their final year of study are also eligible; in such cases, admission with the GRE waiver is contingent upon successful completion of the bachelor's degree.
  - as calculated for admission to the Graduate School ;
  - overall;
  - in the major field; and
  - in all upper-division work.
- The student's UT Arlington grade-point average must equal or exceed 3.0 in the following calculations:

Applicants qualifying for waiver of GRE who do not qualify for advanced admission, must comply with all other requirements for admission, i.e., submitting the application for admission, paying fees, providing official transcripts from other institutions, and meeting any requirements established by the admitting graduate program. The GRE waiver must be recommended by the Graduate Advisor at the time of admission. The waiver of GRE program applies to applicants for master's degree programs only. Some programs may require higher grade-point averages to qualify and some will not waive the GRE under any circumstances.

Additionally, some programs may waive the GRE requirement for non-UT Arlington graduates who seek admission as a master's student and meet qualifications listed in those programs' specific admission requirements. Such waivers are not offered by all graduate programs.

Degree Requirements

Master of Science in Computer Science - Thesis

The Master of Science in Computer Science degree program is designed to develop the scholarship and research skills of the student. It requires 30 credit hours of which six are thesis credits.

Master of Science in Computer Engineering - Thesis

The Master of Science in Computer Engineering, which is intended for students with a baccalaureate degree in engineering, is designed to develop the scholarship and research skills of the student. It requires 30 credit hours of which six are thesis credits.

Master of Science in Computer Science - Non-Thesis

The Master of Science in Computer Science non-thesis option provides professional development in computer science. This option is intended to serve the needs of students who, through their work, have experience doing projects but who do not wish to do a thesis. It requires 36 credit hours.

Master of Science in Computer Engineering - Non-Thesis

The Master of Science in Computer Engineering non-thesis option provides professional development to students with an engineering baccalaureate degree. This option is intended to serve the needs of students who, through their work, have experience doing projects but who do not wish to do a thesis. It requires 36 credit hours.

Master of Software Engineering - Non-Thesis

The Master of Software Engineering provides professional development in software engineering. The program requires 36 credit hours. It includes a 2-course sequence devoted to implementation of a software project.

Admission

The CSE graduate admission committee bases its decision for Ph.D. graduate admission on the following criteria (in no specific order):

- An overall GPA of 3.0 or higher in undergraduate coursework.
- A GPA of 3.2 or higher on CS/CpE/SwE related coursework in the last two years of undergraduate degree.
- For students holding an M.S. degree, similar criteria apply.
- Relevance of the student's degree(s) (background) to the CS/CpE/SwE curriculum.
- Rigor of the student's bachelor's degree and M.S. degree if applicable..
- Reputation of the university/college that the student has received his/her previous degrees from.
- GRE General Test (Optional):
- GRE is currently optional but strongly recommended for the Ph.D. applicants.
- For Ph.D. applicants, three letters of recommendation are needed, as well as a statement of purpose. These should be addressed to Head of Ph.D. Admissions and emailed to: CSEGradAdvising@uta.edu.
- For Ph.D. applicants, the following are optional. Meeting these criteria will improve both a student's chances of securing admission and receiving financial support.
  - Publication in scholarly conferences/journals.
  - A percentile of 80 score or higher on the Computer Science subject GRE.

The above criteria are used as follows in relevance to the three possible admission decisions, i.e., *Unconditional Status*; *Probationary Status*; and *Denied*.

- *Unconditional Status:* Applies to an applicant who meets the first six criteria above to a degree satisfactory to the graduate admissions committee.
- *Probationary Status:* Applies to an applicant who meets at least five of the six criteria to a degree satisfactory to the graduate admissions committee and whose record shows promise for success in the program or to an applicant who does not fulfill all the deficiency course requirements.
- *Denied:*Applies to an applicant who does not meet five of the first six criteria to a degree satisfactory to the graduate admissions committee.

Requirements for BS to PhD Accelerated Program

- An undergraduate degree in CS or CpE or closely related field.
- An overall GPA of 3.0 or higher in undergraduate coursework.
- A 3.2 grade point average (on a 4.0 scale) on the last two years of undergraduate course-work. In particular, performance on CS/CpE related courses are emphasized.
- Rigor of the student's Bachelors degree. A three-year degree is not considered rigorous enough.
- Reputation of the University/College that the student has received his/her previous degrees from.
- GRE General Test (Optional)
- International Applicants A Test of English as a Foreign Language (TOEFL) score - 90 or higher (iBT)

Continuation

To fulfill its responsibility to graduate highly qualified professionals, the Department has established certain requirements that must be met by students continuing in the graduate programs. In addition to the requirements of the Graduate School listed elsewhere in the catalog, the Computer Science and Engineering Department has established additional requirements detailed in its Guide to Graduate Programs.

Assistantships

Students admitted without any probation may qualify for financial support of the following forms:

- Graduate Teaching Assistant (GTA)
- Graduate Research Assistant (GRA)
- Priority is given to PhD students.

Degree Requirements

B.S. to Ph.D. Track

The B.S. to Ph.D. track in Computer Science or Computer Engineering requires 30 credit hours with 21 hours of diagnostic requirements and nine hours of advanced research-oriented coursework. This is in addition to the Ph.D. requirements.

Ph.D. (Computer Science)

The Ph.D. in Computer Science continues the development of the student's research capability for students who already have an MS degree. Coursework selection in each student's program is designed to support the dissertation area selected by the student.

Ph.D. (Computer Engineering)

The Ph.D. in Computer Engineering is available to students with a prior degree in engineering. It contains essentially the same requirements as the Ph.D. (Computer Science) degree except that it permits interdisciplinary research between Computer Science and one or more of the various engineering disciplines.

For all programs, a minimum of two semesters of full-time study is required during the dissertation phase. There is no foreign language requirement.

Graduate Certificate in Artificial Intelligence

PROGRAM OBJECTIVE

This credit-bearing, degree-leading certificate is intended to give those who successfully complete it:

- An ability to understand different AI techniques that have been used for solving real world problems
- An ability to understand the differences and uses of different AI techniques in order to choose from them for solving a problem at hand
- An ability to apply this knowledge to subject areas, such as robotics, image processing, speech recognition, health informatics and bioinformatics, and social networks data

The Certificate is managed by:

- Manfred Huber
- Vassilis Athitsos
- Bahram Khalili, Graduate Advisor

ADMISSION REQUIREMENTS

Current UTA students should contact CSEGradAdvising@uta.edu to sign up for the certificate program. Individuals not currently enrolled at UTA can apply for the certificate via ApplyTexas (https://www.applytexas.org/adappc/gen/c_start.WBX). Should a certificate student wish to continue on to an MS or PhD degree program in the CSE department, most certificate courses may be used toward that advanced degree. Note that for admission to the MS degree program, all UTA and CSE graduate degree admission requirements, including GRE and GPA, would need to be met.

CSE certificate students are required to have an undergraduate preparation equivalent to a baccalaureate degree in Computer Science or Computer Engineering or in a technical field relevant to the CSE curriculum. Students without a proper academic background, as determined by the graduate advisor at the time of the admission review, will be required to complete the CSE 5300 Foundation of Computing course and earn a passing grade in addition to the four required graduate courses.

COURSE REQUIREMENTS

The course requirements for the Artificial Intelligence certificate are:

CSE 5360	ARTIFICIAL INTELLIGENCE I	3
CSE 5364	ROBOTICS	3
CSE 6363	MACHINE LEARNING	3
CSE 6367	COMPUTER VISION	3
Total Hours		**12**

A grade of C or better and an overall GPA of 3.0 or higher is required in all courses counted towards the completion of the certificate. The certificate program consists of 4-5 existing courses. Students enrolled in the certificate program will take courses with students studying for master’s and/or PhD programs in the CSE Department.

FACULTY

The UTA Faculty contributing to this certificate program are:

- Manfred Huber
- Vassilis Athitsos
- Bahram Khalili

Other faculty members of CSE and other departments of the College of Engineering will be contributing to the certificate programs through existing courses included in this certificate program.

Laboratory information can be found via cse.uta.edu (https://www.uta.edu/academics/schools-colleges/engineering/academics/departments/cse/) under the **Faculty Research** heading.

COURSE DESCRIPTIONS

CSE 5300 - Foundation of Computing

Basics of programming, data structures, and algorithms. Introduction to databases and operating systems. Basics of discrete structures and computability. Course is used for the Master's in Data Science degree program and certificate programs for non-CSE majors. It cannot be taken for credit towards any CSE degree.

CSE 5360 - Artificial Intelligence I

Introduction to the methods, concepts and applications of artificial intelligence, including knowledge representation, search, theorem proving, planning, natural language processing, and study of AI programming languages. Prerequisites CSE 2320 and CSE 3315, or CSE 5300, or consent of instructor.

CSE 5364 - Robotics

An introduction to robotics and the design and programming of autonomous robot systems. Topics include basic kinematics, dynamics, and control, as well as sensors, knowledge representation, and programming techniques. Coursework includes individual and group projects involving the building and programming of simulated and real robots. Prerequisites CSE 2320 and CSE 3442, or CSE 5300, or consent of instructor.

CSE 6363 - Machine Learning

A detailed investigation of current machine learning methods, including statistical, connectionist, and symbolic learning. Presents theoretical results for comparing methods and determining what is learnable. Current issues in machine learning research will also be examined. Prerequisites CSE 5301, or CSE 5300, or consent of instructor.

CSE 6367 - Computer Vision

Advanced techniques for interpretation, analysis, and classification of digital images. Topics include methods for segmentation, feature extraction, recognition, stereo vision, 3-D modeling, and analysis of time-varying imagery. Prerequisites CSE 5301, or 5360, or EE 5356, or EE 5357, or CSE 5300, or consent of instructor.

Graduate Certificate in Big Data Management and Data Sciences

PROGRAM OBJECTIVE

This credit-bearing, degree-leading certificate is intended to give those who successfully complete it:

- an ability to understand fundamental concepts of big data management and data sciences, such as data storage and management, and data analysis and mining.
- knowledge of current topics in large scale data analysis, such as relational and non-relational data management, big data analytics, data mining, machine learning, cloud computing, software tools for big data, Web data, and social and information networks.
- an ability to apply this knowledge to subject areas such as business analytics, computational science, health informatics and bioinformatics, and social networks data.

This certificate is managed by:

- Leonidas Fegaras
- Ramez Elmasri
- Bahram Khalili, Graduate Advisor

ADMISSION REQUIREMENTS

Current UTA students should contact CSEGradAdvising@uta.edu to sign up for the certificate program. Individuals not currently enrolled at UTA can apply for the certificate via ApplyTexas (https://www.applytexas.org/adappc/gen/c_start.WBX). Should a certificate student wish to continue on to an MS or PhD degree program in the CSE department, most certificate courses may be used toward that advanced degree. Note that for admission to the MS degree program, all UTA and CSE graduate degree admission requirements, including GRE and GPA, would need to be met.

CSE certificate students are required to have an undergraduate preparation equivalent to a baccalaureate degree in Computer Science or Computer Engineering or in a technical field relevant to the CSE curriculum. Students without a proper academic background, as determined by the graduate advisor at the time of the admission review, will be required to complete the CSE 5300 Foundation of Computing course and earn a passing grade in addition to the four required graduate courses.

COURSE REQUIREMENTS

The course requirements for the Big Data Management and Data Science Certificate are:

CSE 5301	DATA ANALYSIS & MODELING TECHNIQUES	3
CSE 5334	DATA MINING	3
CSE 6331	ADVANCED TOPICS IN DATABASE SYSTEMS	3
CSE 6363	MACHINE LEARNING	3
Total Hours		**12**

A grade of C or better and an overall GPA of 3.0 or higher is required in all courses counted towards the completion of the certificate. The certificate program consists of 4-5 existing courses. Students enrolled in the certificate program will take courses with students studying for master's and/or PhD programs in the CSE Department.

FACULTY

The UTA Faculty contributing to this certificate program are:

- Leonidas Fegaras
- Ramez Elmasri
- Gautam Das
- Sharma Chakravarthy
- Chengkai Li
- David Levine

Other faculty members of CSE and other departments of the College of Engineering will be contributing to the certificate programs through the existing courses included in this certificate program.

Laboratory information can be found via cse.uta.edu (https://www.uta.edu/academics/schools-colleges/engineering/academics/departments/cse/) under the **Faculty Research** heading.

COURSE DESCRIPTIONS

CSE 5300 - Foundation of Computing

Basics of programming, data structures, and algorithms. Introduction to databases and operating systems. Basics of discrete structures and computability. Course is used for the Master's in Data Science degree program and certificate programs for non-CSE majors. It cannot be taken for credit towards any CSE degree.

CSE 5301 - Data Analysis & Modeling Techniques

Concepts and techniques for performing experiments and analyzing their results. Topics cover fundamental statistics, probability and data-representation concepts, interference through hypothesis testing, information theory, queuing models, and selected topics such as capacity planning and bottleneck analysis, clustering and classification, and hidden Markov models with computer science applications as examples.

CSE 5334 - Data Mining

Preparing data for mining, using preprocessing, data warehouses and OLAP; data mining primitives, languages and system architecture, data mining techniques including association rule mining, classification/prediction and cluster analysis.

CSE 6331 - Advanced Topics in Database Systems (Mining, Stream/Complex, Cloud)

The objective of this course is to introduce the student who is interested (and have a background) in databases to some of the advanced topics that are currently being used/applied in industry, and researched by academics. It will cover the following topics as related to databases and information technology: Stream and Complex Event Processing (SP & CEP): pervasive applications, monitoring, principles of stream data processing and its synergy with complex event processing; Mining (graph, SQL-based, and Map/Reduce-based): Need, techniques for knowledge discovery, approaches, algorithms, and Tools, and application areas; association rules; Cloud computing: map/reduce paradigm, solving data and computation intensive problems (e.g., graph mining, page rank) using the new paradigm.

CSE 6363 - Machine Learning

A detailed investigation of current machine learning methods, including statistical, connectionist, and symbolic learning. Presents theoretical results for comparing methods and determining what is learnable. Current issues in machine learning research will also be examined. Prerequisite: CSE 5361, or CSE 5300, or consent of instructor..

Graduate Certificate in Cybersecurity and Privacy

PROGRAM OBJECTIVE

This credit-bearing, degree-leading certificate is intended to give those who successfully complete it:

- an ability to write safe code to prevent common vulnerabilities and design methods to protect systems from attack
- in depth knowledge of fundamental basics of cybersecurity and data privacy, as well as the hot topics such as blockchain and cryptocurrency

This certificate is managed by:

- Jiang Ming
- Ming Li
- Shirin Nilizadeh
- Bahram Khalili, Graduate Advisor

ADMISSION REQUIREMENTS

Current UTA students should contact CSEGradAdvising@uta.edu to sign up for the certificate program. Individuals not currently enrolled at UTA can apply for the certificate via ApplyTexas (https://www.applytexas.org/adappc/gen/c_start.WBX). Should a certificate student wish to continue on to an MS or PhD degree program in the CSE department, most certificate courses may be used toward that advanced degree. Note that for admission to the MS degree program, all UTA and CSE graduate degree admission requirements, including GRE and GPA, would need to be met.

CSE certificate students are required to have an undergraduate preparation equivalent to a baccalaureate degree in Computer Science or Computer Engineering or in a technical field relevant to the CSE curriculum. Students without a proper academic background, as determined by the graduate advisor at the time of the admission review, will be required to complete the CSE 5300 Foundation of Computing course and earn a passing grade in addition to the four required graduate courses.

COURSE REQUIREMENTS

The course requirements for the Cybersecurity and Privacy Certificate are:

CSE 5380	INFORMATION SECURITY 1	3
CSE 5381	INFORMATION SECURITY 2	3
CSE 5382	SECURE PROGRAMMING	3
CSE 6388	SPECIAL TOPICS IN ADVANCED INFORMATION SECURITY	3
Total Hours		**12**

A grade of C or better and an overall GPA of 3.0 or higher is required in all courses counted towards the completion of the certificate. The certificate program consists of 4-5 existing courses. Students enrolled in the certificate program will take courses with students studying for master's and/or PhD programs in the CSE Department.

FACULTY

The UTA Faculty contributing to this certificate program are:

- Jiang Ming
- Ming Li
- Shirin Nilizadeh
- Bahram Khalili

Other faculty members of CSE and other departments of the College of Engineering will be contributing to the certificate programs through the existing courses included in this certificate program.

Laboratory information can be found via cse.uta.edu (https://www.uta.edu/academics/schools-colleges/engineering/academics/departments/cse/) under the **Faculty Research** heading.

COURSE DESCRIPTIONS

CSE 5300 - Foundation of Computing

Basics of programming, data structures, and algorithms. Introduction to databases and operating systems. Basics of discrete structures and computability. Course is used for the Master's in Data Science degree program and certificate programs for non-CSE majors. It cannot be taken for credit towards any CSE degree.

CSE 5380 - Information Security I

Hands-on introduction to the basics of security. Includes system security, buffer overflows, a high-level overview of cryptography, firewalls and IDS/IPS, malware, penetration testing, forensics, and system administration. Prerequisite: CSE 3320, or CSE 5300, or consent of instructor.

CSE 5381 - Information Security II

Deeper study of the fundamentals of security, including symmetric key cryptography, public key cryptography, cryptographic protocols, malware design, network attacks and defenses, data security, privacy, and wireless security. Prerequisite: CSE 5380 and CSE 4344, or CSE 5300, or consent of instructor.

CSE 5382 - Secure Programming

This course is an introduction to methods of secure software design and development for upper-level undergraduate students and graduate students. Students will learn about the major security problems found in software today. Using this knowledge, they will work in teams to find these bugs in software, fix the bugs, and design software so that it has fewer security problems. Static analysis tools will be a core part of the class, but students will also be exposed to black box testing tools. Topics will include input validation, buffer overflow prevention, error handling, web application issues, and XML.

CSE 6388 – Advanced Special Topics in Information Security

This course provides hands-on research training in software security analysis, with a special focus on binary code analysis (e.g., disassembly and data structure reverse engineering), software diversity, symbolic execution, malware unpacking, hardware-assisted malware detection, return-oriented programming: exploitation without code injection, and IoT firmware security.

Graduate Certificate in Deep Learning

PROGRAM OBJECTIVE

This credit-bearing, degree-leading certificate is intended to give those who successfully complete it:

- An ability to understand fundamental concepts of deep learning, such as matrix computation, classification, regression, unsupervised learning, semi-supervised learning and supervised learning
- In depth knowledge of Convolution Neural Networks, Recurrent Neural Networks, Long Short-term Memory, Batch Normalization, Dropout, Stochastic Gradient Descent, Attention Networks, and Transformer
- An ability to apply this knowledge to subject areas, such as image processing, text mining, speech recognition, health informatics and bioinformatics, and social networks data

This certificate is managed by:

- Junzhou Huang
- Vassilis Athitsos
- Bahram Khalili, Graduate Advisor

ADMISSION REQUIREMENTS

Current UTA students should contact CSEGradAdvising@uta.edu to sign up for the certificate program. Individuals not currently enrolled at UTA can apply for the certificate via ApplyTexas (https://www.applytexas.org/adappc/gen/c_start.WBX). Should a certificate student wish to continue on to an MS or PhD degree program in the CSE department, most certificate courses may be used toward that advanced degree. Note that for admission to the MS degree program, all UTA and CSE graduate degree admission requirements, including GRE and GPA, would need to be met.

CSE certificate students are required to have an undergraduate preparation equivalent to a baccalaureate degree in Computer Science or Computer Engineering or in a technical field relevant to the CSE curriculum. Students without a proper academic background, as determined by the graduate advisor at the time of the admission review, will be required to complete the CSE 5300 Foundation of Computing course and earn a passing grade in addition to the four required graduate courses.

COURSE REQUIREMENTS

The course requirements for the Deep Learning certificate are:

CSE 5301	DATA ANALYSIS & MODELING TECHNIQUES	3
CSE 5360	ARTIFICIAL INTELLIGENCE I	3
CSE 5368	NEURAL NETWORKS	3
CSE 6363	MACHINE LEARNING	3
Total Hours		**12**

A grade of C or better and an overall GPA of 3.0 or higher is required in all courses counted towards the completion of the certificate. The certificate program consists of 4-5 existing courses. Students enrolled in the certificate program will take courses with students studying for master's and/or PhD programs in the CSE Department.

FACULTY

The UTA Faculty contributing to this certificate program are:

- Junzhou Huang
- Vassilis Athitsos
- Bahram Khalili
- Dajiang Zhu
- Farhad Kamangar
- Chengkai Li
- Jia Rao
- Won Hwa Kim
- Yingyin Zhu
- Nadra Guzini
- Alex Dillhoff

Other faculty members of CSE and other departments of the College of Engineering will be contributing to the certificate programs through the existing courses included in this certificate program.

Laboratory information can be found via cse.uta.edu (https://www.uta.edu/academics/schools-colleges/engineering/academics/departments/cse/) under the **Faculty Research** heading.

COURSE DESCRIPTIONS

CSE 5300 - Foundation of Computing

Basics of programming, data structures, and algorithms. Introduction to databases and operating systems. Basics of discrete structures and computability. Course is used for the Master's in Data Science degree program and certificate programs for non-CSE majors. It cannot be taken for credit towards any CSE degree..

CSE 5301 - Data Modeling

Concepts and techniques for performing experiments and analyzing their results. Topics cover fundamental statistics, probability and data-representation concepts, interference through hypothesis testing, information theory, queuing models, and selected topics such as capacity planning and bottleneck analysis, clustering and classification, and hidden Markov models with computer science applications as examples.

CSE 5360 - Artificial Intelligence I

Introduction to the methods, concepts and applications of artificial intelligence, including knowledge representation, search, theorem proving, planning, natural language processing, and study of AI programming languages. Prerequisites CSE 2320 and CSE 3315, or CSE 5300, or consent of instructor.

CSE 5368 - Neural Networks

Theoretical principles of Neurocomputing. Learning algorithms, information capacity, and mapping properties of feedforward and recurrent networks. Different neural network models will be implemented and their practical applications discussed. Prerequisites 5301, or CSE 5300, or consent of instructor.

CSE 6363 - Machine Learning

A detailed investigation of current machine learning methods, including statistical, connectionist, and symbolic learning. Presents theoretical results for comparing methods and determining what is learnable. Current issues in machine learning research will also be examined. Prerequisites CSE 5301, or CSE 5300, or consent of instructor.

Graduate Certificate in Embedded Systems

PROGRAM OBJECTIVE

This credit-bearing, degree-leading certificate is intended to give those who successfully complete it the knowledge and skills required to:

- Design and test embedded systems
- Use microcontrollers, system-on-chip, and FPGA devices
- Understand multi-threaded programming on bare-metal, custom real-time operating systems, and embedded Linux systems
- Implement IP stacks for computer networking
- Develop network and wireless protocols for Internet of Things devices
- Design real-time operating systems
- Implement RISC processors in FPGA devices

- Design advanced digital logic systems
- Design control systems with electromechanical actuators and sensors

This certificate is managed by:

- Jason Losh, Program Coordinator
- Bahram Khalili, CSE Graduate Advisor
- Ioannis D. Schizas, EE Graduate Advisor

ADMISSION REQUIREMENTS

Current UTA students should contact CSEGradAdvising@uta.edu to sign up for the certificate program. Individuals not currently enrolled at UTA can apply for the certificate via ApplyTexas (https://www.applytexas.org/adappc/gen/c_start.WBX). Should a certificate student wish to continue on to an MS or PhD degree program in the CSE department, most certificate courses may be used toward that advanced degree. Note that for admission to the MS degree program, all UTA and CSE graduate degree admission requirements, including GRE and GPA, would need to be met.

Acceptance is based on but not limited to the applicant having a degree in Computer Engineering, Electrical Engineering, or requisite background knowledge through active employment in Computer Engineering- or Electrical Engineering-related fields. These certificate students are required to have an undergraduate preparation equivalent to a baccalaureate degree in Computer Science or Computer Engineering or in a technical field relevant to the CSE curriculum.

Please note: Students without a proper academic background, as determined by the graduate advisor at the time of the admission review, may be required to complete CSE 5400 **Fundamentals of Computer Engineering or** EE 5314 **– Embedded Microcontroller Systems if the applicant's bachelor's degree did not include a course in Embedded Systems using the same architecture and device currently used in the Computer Engineering undergraduate program.**

COURSE REQUIREMENTS

The course requirements for the Embedded Systems certificate are:

CSE 5342	EMBEDDED SYSTEMS II (Continuation of content from CSE 3442 and CSE 5400)	3
Plus any three (3) of the following courses:		**9**
CSE 5352	IoT AND NETWORKING (only one of these courses can be taken for credit)	
or EE 6314	ADVANCED EMBEDDED MICROCONTROLLER SYSTEMS	
CSE 5354	REAL-TIME OPERATING SYSTEMS	
CSE 5355	ELECTROMECHANICAL SYSTEMS AND SENSORS	
CSE 5356	SYSTEM ON CHIP (SoC) DESIGN (only one of these courses can be taken for credit)	
or EE 5315	SYSTEM ON CHIP (SOC) DESIGN	
CSE 5357	ADVANCED DIGITAL LOGIC DESIGN	
CSE 5372	RISC PROCESSOR DESIGN	
Total Hours		**12**

* An Advanced Topics in Computer Engineering course (CSE 6351) co-listed with any of the above courses is also acceptable for credit, provided there is not duplication in course content.

A grade of C or better and an overall GPA of 3.0 or higher is required in all courses counted towards the completion of the certificate. Students enrolled in the certificate program will take courses with students studying for master's and/or PhD programs in the CSE or EE Department.

FACULTY

The UTA Faculty contributing to this certificate program are:

- Jason Losh
- Bill Carroll

Other faculty members of CSE and other departments of the College of Engineering will be contributing to the certificate programs through the existing courses included in this certificate program.

Laboratory information can be found via cse.uta.edu (https://www.uta.edu/academics/schools-colleges/engineering/academics/departments/cse/) under the **Faculty Research** heading.

COURSE DESCRIPTIONS

CSE 5400 – Fundamentals of Computer Engineering

Design of digital logic circuits. Design of microcontroller-based systems, including microprocessor programming, component and system architectures, memory interfacing, asynchronous and synchronous serial interfaces, timer-based peripherals, analog to digital (A/D) and digital to analog (D/A) converters, and typical applications.

EE 5314 – Embedded Microcontroller Systems

Hardware/software development techniques for microcontroller systems with an emphasis on hardware-software interactions, programming internal peripherals, interfacing with external sensors and devices, and real-time control applications.

CSE 5342 – Embedded Systems II

Advanced course in design of microcontroller-based systems. Emphasis is on the application of microcontrollers to real-time problems. Topics include the study of the differences in bare metal and embedded Linux implementations, developing applications including PID controllers, and system aspects such as bootloader design and watchdog supervision. Prerequisites CSE 3442, CSE 5400, or consent of instructor.

CSE 5352 – IoT and Networking

Study of protocol stacks and layers, implementation of an Ethernet protocol stack, and design of a basic low-latency, small footprint IoT protocol on bare metal embedded devices and embedded Linux systems. Prerequisites CSE 3442, CSE 5400, or consent of instructor.

CSE 5354 – Real-time Operating Systems

Implementation of a real-time operating system with cooperative and preemption context switching, priority scheduling, semaphores, message queues, and inter-process communications on bare metal microcontrollers. Prerequisites CSE 3442, CSE 5400, or consent of instructor.

CSE 5355 – Electromechanical Systems and Sensors

Applications of electronics and microcontrollers to the control of electromechanical systems. Topics include driving brushless motors (including stepper motors), brushed permanent magnet motors, and other mechanical actuators; the use of the sensors including IMU, LIDAR, RADAR, GPS, capacitive/inductive sensing, laser distance, thermocouples, strain, pressure, optical encoders, and Hall devices; and control applications. Prerequisites CSE 3442, CSE 5400, or consent of instructor.

CSE 5356 – System on Chip (SoC) Design

Programming and implementation of FPGA-based system on chip solutions, including processor subsystems, FPGA fabric, processor to FPGA bridges, and device drivers. Prerequisites CSE 3442, CSE 5400, or consent of instructor.

CSE 5357 – Advanced Digital Logic Design

Hierarchical organization, design, simulation, implementation, and testing of digital systems. Industrial standard computer-aided design tools including hardware description languages (HDLs), field-programmable gate arrays (FPGAs), and other prototyping hardware and software will be employed. Design of arithmetic and other algorithmic processes will be covered. A term project will be required. Prerequisites CSE 3442, CSE 5400, or consent of instructor.

CSE 5372 – RISC Processor Design

Design of a RISC processor, based on RISC V and custom instruction set architectures with implementation on an FPGA target for test and verification. Prerequisites CSE 3442, CSE 5400, or consent of instructor.

EE 5315 – System on Chip (SoC) Design

Programming and implementation of FPGA-based system on chip solutions, including processor subsystems, FPGA fabric, processor to FPGA bridges, and device drivers. Prerequisite EE 5314.

EE 6314 – Advanced Embedded Microcontroller Systems

Study of advanced microcontroller system designs with an emphasis on multi-tasking, real-time control of devices. Topics include: design of real-time control systems, design of bootloaders, USB peripherals, and Ethernet applications. Prerequisite EE 5314.

CSE 6351 – Advanced Topics in Computer Engineering

May be repeated for credit when topics change. Prerequisite CSE 5342 or consent of instructor.

Graduate Certificate in Field-Programmable Gate Array (FPGA) and System on Chip (SoC) Design

PROGRAM OBJECTIVE

This credit-bearing, degree-leading certificate is intended to give those who successfully complete it the knowledge and skills required to:

- Design and test advanced digital logic systems
- Use industry-standard HDL tools
- Use bridges to interconnect FPGA fabric and processor subsystems
- Write Linux device drivers
- Implement soft RISC processors in FPGA devices

This certificate is managed by:

- Jason Losh, Program Coordinator
- Bahram Khalili, Graduate Advisor

ADMISSION REQUIREMENTS

Current UTA students should contact CSEGradAdvising@uta.edu to sign up for the certificate program. Individuals not currently enrolled at UTA can apply for the certificate via ApplyTexas (https://www.applytexas.org/adappc/gen/c_start.WBX). Should a certificate student wish to continue on to an MS or PhD degree program in the CSE department, most certificate courses may be used toward that advanced degree. Note that for admission to the MS degree program, all UTA and CSE graduate degree admission requirements, including GRE and GPA, would need to be met.

Acceptance is based on but not limited to the applicant having a degree in Computer Engineering, Electrical Engineering, or requisite background knowledge through active employment in Computer Engineering- or Electrical Engineering-related fields.

CSE certificate students are required to have an undergraduate preparation equivalent to a baccalaureate degree in Computer Science or Computer Engineering or in a technical field relevant to the CSE curriculum. Students without a proper academic background, as determined by the graduate advisor at the time of the admission review, may be required to complete CSE 5400 Fundamentals of Computer if the applicant's bachelor's degree did not include a course in Embedded Systems using the same architecture and device currently used in the Computer Engineering undergraduate program.

COURSE REQUIREMENTS

The course requirements for the FPGA and SoC Design certificate are:

CSE 5356	SYSTEM ON CHIP (SoC) DESIGN	3
CSE 5357	ADVANCED DIGITAL LOGIC DESIGN	3
CSE 5372	RISC PROCESSOR DESIGN	3
Total Hours		**9**

* An Advanced Topics in Computer Engineering course (CSE 6351) co-listed with any of the above courses is also acceptable for credit, provided there is not duplication in course content.

A grade of C or better and an overall GPA of 3.0 or higher is required in all courses counted towards the completion of the certificate. Students enrolled in the certificate program will take courses with students studying for master's and/or PhD programs in the CSE Department.

FACULTY

The UTA Faculty contributing to this certificate program are:

- Jason Losh
- Bill Carroll

Other faculty members of CSE and other departments of the College of Engineering will be contributing to the certificate programs through the existing courses included in this certificate program.

Laboratory information can be found via cse.uta.edu (https://www.uta.edu/academics/schools-colleges/engineering/academics/departments/cse/) under the **Faculty Research** heading.

COURSE DESCRIPTIONS

CSE 5400 – Fundamentals of Computer Engineering

Design of digital logic circuits. Design of microcontroller-based systems, including microprocessor programming, component and system architectures, memory interfacing, asynchronous and synchronous serial interfaces, timer-based peripherals, analog to digital (A/D) and digital to analog (D/A) converters, and typical applications.

CSE 5356 – System on Chip (SoC) Design

Programming and implementation of FPGA-based system on chip solutions, including processor subsystems, FPGA fabric, processor to FPGA bridges, and device drivers. Prerequisites CSE 3442, CSE 5400, or consent of instructor.

CSE 5357 – Advanced Digital Logic Design

Hierarchical organization, design, simulation, implementation, and testing of digital systems. Industrial standard computer-aided design tools including hardware description languages (HDLs), field-programmable gate arrays (FPGAs), and other prototyping hardware and software will be employed. Design of arithmetic and other algorithmic processes will be covered. A term project will be required. Prerequisites CSE 3442, CSE 5400, or consent of instructor.

CSE 5372 – RISC Processor Design

Design of a RISC processor, based on RISC V and custom instruction set architectures with implementation on an FPGA target for test and verification. Prerequisites CSE 3442, CSE 5400, or consent of instructor.

CSE 6351 – Advanced Topics in Computer Engineering

May be repeated for credit when topics change. Prerequisite CSE 5342 or consent of instructor.

Graduate Certificate in Real-Time Systems

PROGRAM OBJECTIVE

This credit-bearing, degree-leading certificate is intended to give those who successfully complete it the knowledge and skills required to:

- Design and test advanced digital logic systems
- Use industry-standard HDL tools
- Use bridges to interconnect FPGA fabric and processor subsystems
- Write Linux device drivers
- Implement soft RISC processors in FPGA devices

This certificate is managed by:

- Jason Losh, Program Coordinator
- Bahram Khalili, Graduate Advisor

ADMISSION REQUIREMENTS

Current UTA students should contact CSEGradAdvising@uta.edu to sign up for the certificate program. Individuals not currently enrolled at UTA can apply for the certificate via ApplyTexas (https://www.applytexas.org/adappc/gen/c_start.WBX). Should a certificate student wish to continue on to an MS or PhD degree program in the CSE department, most certificate courses may be used toward that advanced degree. Note that for admission to the MS degree program, all UTA and CSE graduate degree admission requirements, including GRE and GPA, would need to be met.

Acceptance is based on but not limited to the applicant having a degree in Computer Engineering, Electrical Engineering, or requisite background knowledge through active employment in Computer Engineering- or Electrical Engineering-related fields.

CSE certificate students are required to have an undergraduate preparation equivalent to a baccalaureate degree in Computer Science or Computer Engineering or in a technical field relevant to the CSE curriculum. Students without a proper academic background, as determined by the graduate advisor at the time of the admission review, may be required to complete CSE 5400 Fundamentals of Computer Engineering or EE 5314 – Embedded Microcontroller Systems if the applicant's bachelor's degree did not include a course in Embedded Systems using the same architecture and device currently used in the Computer Engineering undergraduate program.

COURSE REQUIREMENTS

The course requirements for the Real-Time Systems certificate are:

CSE 5342	EMBEDDED SYSTEMS II	3
CSE 5354	REAL-TIME OPERATING SYSTEMS	3

CSE 5355	ELECTROMECHANICAL SYSTEMS AND SENSORS	3
CSE 5356	SYSTEM ON CHIP (SoC) DESIGN	3
Total Hours		**12**

* An Advanced Topics in Computer Engineering course (CSE 6351) co-listed with any of the above courses is also acceptable for credit, provided there is not duplication in course content.

A grade of C or better and an overall GPA of 3.0 or higher is required in all courses counted towards the completion of the certificate. Students enrolled in the certificate program will take courses with students studying for master's and/or PhD programs in the CSE Department.

FACULTY

The UTA Faculty contributing to this certificate program are:

- Jason Losh
- Bill Carroll

Other faculty members of CSE and other departments of the College of Engineering will be contributing to the certificate programs through the existing courses included in this certificate program.

Laboratory information can be found via cse.uta.edu (https://www.uta.edu/academics/schools-colleges/engineering/academics/departments/cse/) under the **Faculty Research** heading.

COURSE DESCRIPTIONS

CSE 5400 – Fundamentals of Computer Engineering

Design of digital logic circuits. Design of microcontroller-based systems, including microprocessor programming, component and system architectures, memory interfacing, asynchronous and synchronous serial interfaces, timer-based peripherals, analog to digital (A/D) and digital to analog (D/A) converters, and typical applications.

CSE 5356 – System on Chip (SoC) Design

Programming and implementation of FPGA-based system on chip solutions, including processor subsystems, FPGA fabric, processor to FPGA bridges, and device drivers. Prerequisites CSE 3442, CSE 5400, or consent of instructor.

CSE 5342 – Embedded Systems II

Advanced course in design of microcontroller-based systems. Emphasis is on the application of microcontrollers to real-time problems. Topics include the study of the differences in bare metal and embedded Linux implementations, developing applications including PID controllers, and system aspects such as bootloader design and watchdog supervision. Prerequisites CSE 3442, CSE 5400, or consent of instructor.

CSE 5354 – Real-time Operating Systems

Implementation of a real-time operating system with cooperative and preemption context switching, priority scheduling, semaphores, message queues, and inter-process communications on bare metal microcontrollers. Prerequisites CSE 3442, CSE 5400, or consent of instructor.

CSE 5355 – Electromechanical Systems and Sensors

Applications of electronics and microcontrollers to the control of electromechanical systems. Topics include driving brushless motors (including stepper motors), brushed permanent magnet motors, and other mechanical actuators; the use of the sensors including IMU, LIDAR, RADAR, GPS, capacitive/inductive sensing, laser distance, thermocouples, strain, pressure, optical encoders, and Hall devices; and control applications. Prerequisites CSE 3442, CSE 5400, or consent of instructor.

CSE 5356 – System on Chip (SoC) Design

Programming and implementation of FPGA-based system on chip solutions, including processor subsystems, FPGA fabric, processor to FPGA bridges, and device drivers. Prerequisites CSE 3442, CSE 5400, or consent of instructor.

CSE 6351 – Advanced Topics in Computer Engineering

May be repeated for credit when topics change. Prerequisite CSE 5342 or consent of instructor.

Graduate Certificate in Unmanned Vehicle Systems

PROGRAM OBJECTIVE

This credit-bearing, degree-leading certificate is intended to give those who successfully complete it:

- the knowledge and skills required for the design, development, and operation of UVS including UAS (Unmanned Aerial Systems), UGS (Unmanned Ground Systems) and UMS (Unmanned Maritime Systems)
- an ability to understand the common aspects of UVS including sensors, actuators, communications, powering, and more importantly decision# making capabilities (autonomy), while also covering development of domain#specific mobile platforms such as airplane, rotorcraft, and Ackerman steering car and boat
- an ability to provide the UVS industry with a knowledgeable, locally available workforce and developing career opportunities for its participants

The certificate is managed by:

- Manfred Huber
- Vassilis Athitsos
- Farhad Kamangar
- Bahram Khalili, Graduate Advisor

ADMISSION REQUIREMENTS

Current UTA students should contact CSEGradAdvising@uta.edu to sign up for the certificate program. Individuals not currently enrolled at UTA can apply for the certificate via ApplyTexas (https://www.applytexas.org/adappc/gen/c_start.WBX). Should a certificate student wish to continue on to an MS or PhD degree program in the CSE department, most certificate courses may be used toward that advanced degree. Note that for admission to the MS degree program, all UTA and CSE graduate degree admission requirements, including GRE and GPA, would need to be met.

CSE certificate students are required to have an undergraduate preparation equivalent to a baccalaureate degree in Computer Science or Computer Engineering or in a technical field relevant to the CSE curriculum. Students without a proper academic background, as determined by the graduate advisor at the time of the admission review, will be required to complete the CSE 5300 Foundation of Computing course and earn a passing grade in addition to the four required graduate courses.

COURSE REQUIREMENTS

The course requirements for the Unmanned Vehicle Systems Certificate will be:

CSE 5360	ARTIFICIAL INTELLIGENCE I	3
CSE 5364	ROBOTICS	3
CSE 5383	INTRODUCTION TO UNMANNED VEHICLE SYSTEMS	3
CSE 5384	UNMANNED VEHICLE SYSTEM DEVELOPMENT	3
Total Hours		**12**

A grade of C or better and an overall GPA of 3.0 or higher is required in all courses counted towards the completion of the certificate. The certificate program consists of 4-5 existing courses. Students enrolled in the certificate program will take courses with students studying for master’s and/or PhD programs in the CSE Department.

FACULTY

The UTA Faculty contributing to this certificate program are:

- Manfred Huber
- Vassilis Athitsos
- Farhad Kamangar
- Bahram Khalili

Other faculty members of CSE and other departments of the College of Engineering will be contributing to the certificate programs through the existing courses included in this certificate program.

Laboratory information can be found via cse.uta.edu (https://www.uta.edu/academics/schools-colleges/engineering/academics/departments/cse/) under the **Faculty Research** heading.

COURSE DESCRIPTIONS

CSE 5300 - Foundation of Computing

Basics of programming, data structures, and algorithms. Introduction to databases and operating systems. Basics of discrete structures and computability. Course is used for the Master's in Data Science degree program and certificate programs for non-CSE majors. It cannot be taken for credit towards any CSE degree.

CSE 5360 - Artificial Intelligence I

Introduction to the methods, concepts and applications of artificial intelligence, including knowledge representation, search, theorem proving, planning, natural language processing, and study of AI programming languages. Prerequisites CSE 2320 and CSE 3315, or CSE 5300, or consent of instructor.

CSE 5364 - Robotics

An introduction to robotics and the design and programming of autonomous robot systems. Topics include basic kinematics, dynamics, and control, as well as sensors, knowledge representation, and programming techniques. Coursework includes individual and group projects involving the building and programming of simulated and real robots. Prerequisites CSE 2320 and CSE 3442, or CSE 5300, or consent of instructor.

CSE 5383 - Introduction to Unmanned Vehicle Systems

Introduction to UVS (Unmanned Vehicle Systems) such as UAS (Unmanned Aircraft Systems), UGS (Unmanned Ground System) and UMS (Unmanned Maritime System), their history, missions, capabilities, types, configurations, subsystems, and the disciplines needed for UVS development and operation. UVS missions could include student competitions sponsored by various technical organizations. This course is team-taught by engineering faculty.

CSE 5384 - Unmanned Vehicle System Development

Introduction to the technologies needed to create an UVS (Unmanned Vehicle System). Integration of these technologies (embodied as a set of sensors, actuators, computing and mobility platform sub-systems) into a functioning UVS through teamwork. UVS could be designed to compete in a student competition sponsored by various technical organizations or to support a specific mission or function defined by the instructors. This course is team-taught by engineering faculty. Prerequisite: B or better in CSE 4378, CSE 5383 or CSE 5300, or consent of instructor.