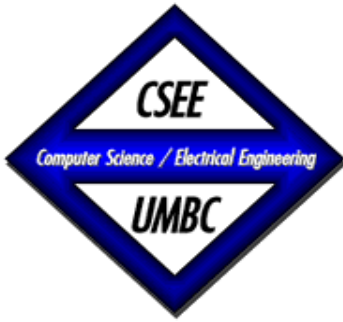The CSEE Department may change the policies and procedures contained in this document and will maintain a current and accurate version in the department's files.

Department of Computer Science and Electrical Engineering
University of Maryland, Baltimore County

Computer Science
Graduate Program Handbook
May 2021
http://www.cs.umbc.edu/CSEE/

Graduate Program Director: Dr. Charles Nicholas

(nicholas@umbc.edu)

Graduate Program Coordinator: Mrs. Keara Fliggins

(fliggins@umbc.edu)

UMBC is a major research university, located in the Baltimore/Washington area, which offers graduate students an exciting environment for advanced study.   With nearly 15,000 undergraduate and graduate students in the liberal arts, sciences, engineering, and public policy, UMBC is large enough to provide students with excellent training and research experience, and small enough for close interaction between students and faculty.   The University is a growing center for research and development and technology commercialization.   Adjacent to the campus, the UMBC Technology Center houses a number of research, development, and training organizations seeking interaction with University faculty, students, and research facilities.

In the CSEE Department, graduate programs are strongly supported by the industrial companies in the greater Baltimore-Washington area, and various collaborative arrangements with governmental and private institutions make state-of-the-art research facilities in the area available to UMBC faculty and students. The Department offers M.S. (with thesis or non-thesis option) and Ph.D. degrees in computer science (CS), in electrical engineering (EE), and in computer engineering (CE).   The department also offers a systems engineering track under the M.S. in EE , and the M.P.S. degrees in Data Science and Cybersecurity. Separate admissions committees handle admission to each program.   More information on these programs is available on their respective web sites.

Prospective Students: We hope you found the information useful, and we look forward to hearing from you (the contact information is listed on the CSEE graduate program

website).   Questions about the application process, the status of your application, and related matters should be directed to Graduate Program Coordinator Keara Fliggins (fliggins@umbc.edu).

Admitted Students: Please read this document carefully, lengthy as it is! It will make you more aware of the program's requirements and the various milestones/forms. You will be assigned a "temporary" advisor once you inform us that you plan to attend UMBC, and that person will be able to answer questions that you have about our programs. We wish you success in your graduate studies at UMBC!

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Overview

The CSEE department offers graduate programs leading to the M.S. and Ph.D. degrees in computer science.   This program provides advanced instruction, training, and research opportunities that prepare students for careers and that foster marketable skills in industry, academia, and government.

The Student Learning Outcomes for the programs adopted by the faculty some years ago include:

1. Knowledge of the fundamental design and development principles of computer systems, the theoretical foundations of computer science, and an additional 'breadth' area of computer science.
2. Knowledge of one or more additional topic areas of computer science.
3. Ability to critically analyze prior research in their area.
4. In-depth knowledge of their chosen research area.
5. Ability to perform independent original research, including the ability to formulate research questions pertinent to their area, and the ability to answer them via theoretical analysis or experimentally via system design and/or development.
6. Ability to effectively communicate and defend their research findings to scientific peers in both written and oral formats.
7. The Ph.D. program has an additional outcome: Ability to conduct original research that substantively contributes to the knowledge in their research area.

The program reflects state-of-the-art knowledge in major theoretical and applied aspects of computation. Fields of specialization in CS include:

Algorithms, theory and scientific computation:

- algebraic coding theory,
- analysis of algorithms,
- combinatorial optimization,
- computational complexity,
- cryptology and cryptography,
- quantum computing

Computer networks and systems:

- computer and communication networks,
- computer security,
- distributed systems,
- mobile computing,
- network security,

- optical networking,
- wireless networking

Databases, information, and knowledge management:

- artificial intelligence,
- database systems,
- data mining
- digital libraries,
- information retrieval,
- intelligent information systems,
- knowledge representation and reasoning,
- machine learning,
- neural networks,
- natural language processing,

Graphics, animation, and visualization:

- animation,
- interactive 3D graphics,
- physically based modeling,
- procedural modeling,
- volumetric visualization and rendering

1.   Program Admission

General Policy: When seeking admission to the graduate program, applicants must satisfy the entrance requirements of the Graduate School at UMBC.   Applications are not processed until all documents and fees are received.   Applicants must submit transcripts, three letters of recommendation, statement of purpose, Graduate Record Examination (GRE General Test) scores, and, for international students, scores for the TOEFL, IELTS, or Duolingo exams.   Unofficial copies of documents may be submitted with the application, but official documents will be required if admission is granted. The GRE may be waived for M.S. students under certain circumstances, described below. Students may apply online at: www.umbc.edu/gradschool/procedures/forms.html

Students may apply for admission to either the M.S. or the Ph.D. program.   Admission to the Ph.D. program is highly selective and only students with excellent credentials will be accepted.   Students who plan to pursue the Ph.D. degree, but who either do not have extensive research experience during their undergraduate studies (or at work) or do not already have an M.S. in computer science, are advised to apply for admission to the M.S. program.

Admission and financial assistance decisions are based on several factors, including undergraduate and graduate (if applicable) academic performance, GRE and TOEFL scores, recommendation letters, the statement of purpose, prior research experience and publication history.   In particular, candidates applying to the Ph.D. program should have a prior research record, and submit a credible statement of purpose clearly describing their research interests and future career goals. Newly admitted students will be assigned an academic advisor who can provide advice on choice of courses, degree requirements, and other important matters during the first year.   By the end of the first year, students should have selected a faculty member who has agreed to serve as the research advisor for the M.S. or Ph.D. research.

1.1 Application Deadlines

The application review process will begin by January 1 for admission to the Fall semester and by October 1 for admission to the following Spring semester.   Favorable consideration will be given to applications received early in each review cycle.   It is the policy of the department to admit students based solely on their academic and research performance.

Applicants often ask:

- Are these deadlines firm? Yes.
- Are unofficial transcripts acceptable? Yes, but if we offer admission we will require official documents.
- Are letters of recommendation written only by professors? No, we can accept letters from any person qualified to attest to your ability.
- Are recipients of three-year degrees eligible to apply? Yes. We look at total

credits, and whether the prerequisite courses are satisfied, rather than the length of time in your degree program.

While we do welcome applicants for either the Fall or Spring semesters, those considering Spring admission should be aware of three potential difficulties: First, the number of TA positions available for Spring students is quite limited, compared to Fall students. Second, seats in popular classes are harder to get in the Spring than in the Fall, since so many students are beginning their fourth semester of study. Third, for those coming to UMBC on an F-1 student visa, the option of Curricular Practical Training (CPT) is not available until the student has finished two semesters of study. Students admitted in the Spring therefore cannot use CPT that following summer, and lose the option of taking a summer job or internship. We offer few graduate courses in the summer, so Spring students are at a disadvantage in terms of using their summer break in a productive manner. For these reasons, we strongly advise students to choose Fall admission.

APPLICATION DEADLINES

Domestic applicants (U.S. citizens and permanent residents) not seeking financial support

Fall semester - June 1

Spring semester - November 1

Domestic students seeking departmental financial support; and all international students

Fall semester - January 1

Spring semester - July 1 of the prior calendar year

GRE WAIVER REQUEST DEADLINES

Fall semester – February 1

Spring semester – August 1

1.2 GRE Requirements and Waiver Requests

The Graduate Record Examinations (GREs) provide the department with standardized data for comparing applicants from many parts of the world with very different backgrounds. Thus, the GRE scores are required for most applicants. In some situations, the GRE is not needed for the department to make an admissions decision and a GRE waiver may be granted.

These are the qualifications for *requesting* a GRE waiver:

a) you are an M.S. or a Ph.D. applicant and you have, or are about to receive, a BS degree with a cumulative GPA of 3.5 or higher from an accredited US institution;

or

b) you are a Ph.D. applicant and you have completed an M.S. degree from an accredited US institution.

Please take note of the following points:

- ~~GRE scores are required for students requesting departmental financial assistance.~~ *We are waiving the GRE for Fall 2021 and Spring 2022 applicants, due to the ongoing public health crisis. We still recommend the GREs for those who have access to it.*

- You must submit a GRE Waiver Request by February 1 for admission in the Fall semester or by August 1 for admission in the Spring semester.

- Qualifying for a GRE Waiver Request does not imply *approval* of the request. Your request will be granted if the Computer Science Graduate Admissions Committee agrees that GRE scores are not needed to make an admission decision in your case.

- UMBC students in the Computer Science BS/MS program do not need to take the GREs. These students should indicate that they are in the BS/MS program in their application. They do not need to submit a GRE Waiver Request.

How to submit a GRE Waiver Request:

The GRE Waiver Request form is available on the CSEE website http://www.csee.umbc.edu/wp-content/uploads/2011/01/CS_GRE_Waiver_Request.pdf

Submit the completed *GRE Waiver Request* form with your resume and a transcript from the US institution of your BS or MS degree to Mrs. Keara Fliggins via email at fliggins@umbc.edu. If your resume and transcript have already been submitted to the UMBC Graduate School for your application, please indicate this on the request form. Unofficial transcripts are acceptable for the GRE Waiver Request. You will be notified by email regarding the decision made in response to your request.

Applicants often ask:

- What is the minimal GRE score needed for admission? We have no set lower bounds. But most successful applicants score in the 70th percentile or higher on the quantitative exam, and in the 50th percentile or higher on the verbal exam.
- What should be done if the GRE exam is not available until after the admission deadline? Go ahead and send in your materials, and arrange for the GRE scores to be sent to us once you have taken the exam.

1.3 Prerequisites for Admission

Applicants to the graduate program in computer science are expected to have a strong background in computer science and mathematics. Specifically, applicants are expected to have taken the equivalent of the following UMBC courses:

- CMSC 203 Discrete Structures
- CMSC 313 Computer Organization and Assembly Language
- CMSC 331 Principles of Programming Languages
- CMSC 341 Data Structures
- CMSC 411 Computer Architecture
- CMSC 421 Principles of Operating Systems
- CMSC 441 Algorithm Design and Analysis
- MATH 151 Calculus I
- MATH 152 Calculus II
- MATH 221 Introduction to Linear Algebra
- At least one more advanced course in mathematics.

Students who lack one or two of the courses listed above are welcome to apply, with the understanding they may be advised to take those courses if and when they're admitted. Students who lack the computer science background we expect may wish to enroll at UMBC or some other university as a non-degree student, which will permit them to take the courses they need before applying for admission to our graduate programs. At this time, non-degree status is available to international students only on an exceptional basis, as described on the UMBC Graduate School web site.

Students who are enrolled in some other graduate program at UMBC are expected to meet these same requirements for admission, and compete for financial aid on the same basis as other applicants.

Prospective applicants who are employed in local industry (public or private sector) are welcome to apply. We offer many of our courses in the late afternoon or evening hours. However, some courses required for the M.S. or Ph.D. degrees tend to be offered in the daytime hours. Students are encouraged to work with their employers to gain the flexibility to take these courses when offered, to avoid delay in fulfilling these requirements. Students employed in local industry are welcome to consider thesis (CMSC 799) or writing project (CMSC 698) topics that dovetail with their work.

2   Financial Assistance

Financial aid is available on a competitive basis to a limited number of qualified graduate students in the form of graduate teaching assistantships (TAs) and graduate research assistantships (RAs).   Preference for TAs is given to first-year Ph.D. applicants.

TA and grader positions in the computer science program are restricted to graduate students in computer science.

Prospective students should be aware that their applications are used for decisions regarding both admission and financial aid, but these are separate decisions. We understand that many students will be unable to attend unless some aid is offered, but at any given time we have many more deserving students than available TA positions. For the Fall admission cycle, TA offers are usually made within a month of admission offers.

Students who are offered admission without financial support are welcome to enter our M.S. program, but opportunities for newly-arrived students in this category are limited. We therefore recommend that MS students plan to support themselves during *at least* their first year of study.

Graduate RAs are often available to students actively engaged in M.S. thesis or Ph.D. dissertation research and are awarded and renewed subject to availability of funds and satisfactory research progress.   RA positions are normally not available to incoming M.S. students.

Students are encouraged to apply directly to nationally awarded fellowship programs.

Students who have been supported on departmental TA-ships for three or more semesters and who seek the M.S. degree are required to take the thesis option (except for Ph.D. students who have passed the portfolio within the specified time limits).

Financial assistance decisions are based on several factors including academic performance, GRE and TOEFL scores, recommendation letters, statements of purpose, research experience and publication history.

The following is the recommended priority order in awarding teaching assistantships to incoming students:

1. Priority will be given to students with excellent academic credentials from reputable universities, a strong publication record, high GRE scores, strong support letters, who have already earned an M.S. degree in computer science and demonstrate a genuine wish to pursue the Ph.D. degree.

2. Students with excellent academic credentials from reputable universities, high GRE scores, strong support letters, a B.S degree in computer science and a desire to pursue either the M.S. or Ph.D. degree.   If a student with a B.S. degree expresses interest in the Ph.D. program, the application has to be backed up by strong research participation as an undergraduate (with publications desirable).

3. Students who have any CMSC or other prerequisite courses unfulfilled will generally not be admitted with TA support.

We welcome applications submitted via a third party, such as Educo (www.educosoft.com). However, such applicants are not, in general, eligible for financial aid from the department until at least their second semester of study.

2.1 Departmental Financial Aid for Continuing Students

Continued departmental support as a TA depends upon several factors. The minimum prerequisites to be eligible for TA support are: strong academic performance, strong TA performance if the student had been a TA/grader, meeting the required milestones, and a strong letter of support from the research advisor. There is also an upper limit on the number of semesters a student may be supported by the department (see *Notes* below).

Students who hold TA or RA positions are welcome to hold outside jobs through Curricular Practical Training (CPT) as long as the employment does not interfere with their studies or their TA/RA duties. The student's advisor must sign off on the CPT paperwork before it will be approved by the department.

The following is the priority order for continuing students:

1. Ph.D. students who have passed their Preliminary Examinations and are within the specified time limits.

2. Ph.D. students who have passed their portfolio, but have not yet taken their Prelims and are within the specified time limit.

3. Ph.D. students who have not yet passed their portfolio. This will apply to students in their second year; strong academic performance, satisfactory TA performance and evidence of research will be considered.

4. Students are allowed to hold internships through CPT during the academic year, as long as it does not interfere with their studies. However, CPT students are at a lower priority than other unsupported studies when TA positions are being filled.

Notes:

1. For Ph.D. students, departmental TA-ships will be limited to a total of eight semesters of support (whether as full-TA, half-TA or grader). Requests for an additional two semesters may be considered, but support will be provided only to exceptionally qualified students in such cases.

   In general, Ph.D. students will not be eligible for TA support past their fifth year in the CMSC graduate program.

   Other comments:

   - If a Ph.D. student was supported by the department while the student was in the M.S. program, those semesters will count towards the maximum limit.

- Any semester in which a student independently teaches a course does not count towards the maximum.

2. For M.S. students, departmental TA-ships will be limited to four semesters of support (whether full-TA, half-TA or grader) in compliance with priority #4 above.

3. In any given category, if there are more students than available lines, a combination of factors will be used in granting support, including publication history/research record, academic excellence, a strong letter of support from the advisor, excellence in past TA performance, and qualifications and knowledge for the course we need.

2.2 TA Responsibilities

1. As a TA, it is your responsibility to be fully familiar with the course material and all the assignments.   You may have to spend time and effort in learning the material.   As graduate students in computer science, you are expected to know (or otherwise learn) the material for the core and mainstream undergraduate courses. The department does its best in matching background knowledge and prior experience of students to their respective TA/grader assignments.

   Students are expected to be available to assist with course/lab development. Inadequate prior knowledge of the course material is not an excuse for incompetent performance as a TA/grader.

2. **Students supported as full-time TAs are required to be full-time students, i.e. by completing nine graduate-level credits per semester.**

3. **TA renewal is not automatic.**   Renewal is based on satisfactory academic and TA performance and other factors.

4. Students who receive an "academic warning" status for poor academic performance might lose their teaching assistantship in the semester that they are so classified.   Students who receive an "academic probation" status will lose their teaching assistantship immediately.

5. Tuition remission will not exceed the minimum number of credits required for the M.S. degree, and will be granted only to courses that will count towards the degree.

6. Except under special circumstances, M.S. students with no TA experience must have grader experience to be considered for a TA.

7. TAs are required to be on campus by January 15 for Spring semester and by August 10 for the Fall semester.   Exceptions have to be requested in writing at least 3 weeks before these dates.   Teaching assistants who are not present on the first day of class risk having their TA appointment terminated!

8. If you feel that you are being overworked or abused as a TA or grader, please

inform the Graduate Program Director immediately.   Please maintain a history of hours worked per week.

The following table describes the various tasks that a TA and a grader are expected to perform:

Duties	TA	Grader
Grade projects, homework, etc.	Yes	Yes
Hold office hours	Yes, for questions related to course lectures or grading	Yes, but **only** for questions related to grading
Prepare project or homework solutions	Yes	If an intrinsic part of understanding the grading for a particular subject
Proctor exams	Yes	Yes
Generate homework questions	Yes	No
Run labs, help sessions	Yes	No
Give prepared lectures	Only under unusual circumstances	No

3   Requirements for the M.S. Degree in Computer Science

Summary of Requirements for the M.S. Degree in Computer Science
24 credits of graduate coursework plus six credits of CMSC 799 (thesis option) **or**
33 credits of graduate coursework (non-thesis option)
Both options require the following mix of courses including CMSC 641 Algorithms, plus at least one from the "systems" set {CMSC 611 Computer Architecture, CMSC 621 Operating Systems, CMSC 661 Database, CMSC 681 Networks} and at least one from the "applications" set {CMSC 626 Computer Security, CMSC 634 Computer Graphics, CMSC 671 Artificial Intelligence, CMSC 678 Machine Learning}
Certain restrictions apply as described below
CMSC 698 Writing Project is available as an elective
A minimum overall GPA of 3.0 is required to graduate
Completing the program within a maximum of five years
Completing each of the milestones according to the timeline specified below.

For the M.S. degree in computer science, the student must earn a minimum of thirty (30) credit hours with the thesis option, or thirty-three (33) credit hours with the non-thesis option.

The time limit for completing the degree is five years from starting the graduate program at UMBC.

The thesis option requires a minimum of eight (8) graduate-level- courses (24 credit hours) and six (6) credit hours of thesis (CMSC 799). The thesis must be supervised by an approved CSEE graduate faculty member as the thesis advisor; and must, upon completion of the research, be defended with an oral presentation and accepted by the student's M.S. thesis committee. The non-thesis option in the student's field requires a minimum of ten (11) graduate level courses (33 credit hours).

The elective course CMSC 698 (Research Project) involves work resulting in a scholarly paper that must be approved by the advisor and read by another faculty member. A copy of the scholarly paper must be submitted to the department.

3.1 M.S. Program Guidelines

The required slate of courses provide a minimal background in theoretical computer science, computer systems, and applications, while providing the flexibility to allow students to pursue their own interests. The required courses include:

- CMSC 641 Algorithms
- At least one from the set of "Systems" courses {CMSC 611 Computer Architecture, CMSC 621 Operating Systems, CMSC 661 Database, CMSC 681 Networks}
- At least one from the set of "Applications" courses {CMSC 626 Computer Security, CMSC 634 Computer Graphics, CMSC 671 Artificial Intelligence, CMSC 678 Machine Learning}

The following restrictions apply.

1. At most six total credits of CMSC 699 (P/F) or CMSC 791 (P/F) or CMSC 696 (P/F) will be allowed.

2. A student may request to take a **maximum of six credits of coursework outside the department.** These courses must be at the graduate level and be approved by the student's advisor and the Graduate Program Director prior to registration.

   Requests for approval of non-CMSC course credits (at most 6 credits) should be submitted before registering for the non-CMSC course. The request form should be signed by the student's research advisor.

3. A regular graduate-level course taken for (P/F) credit may not be counted towards the degree.

4. At most six **graduate-level credits** taken at another university may be **transferred** to count towards the M.S. degree, provided that the credits have not been used for another degree. Credit transfer must be approved by the Director of the Graduate program. To request a credit transfer, submit the Graduate School's *Course Transfer Request* form along with required documentation (see the Forms webpage of the CMSC graduate program).

5. All transfer course approvals and non-CMSC course credit approvals should be obtained before submitting the Graduate School's *Fulfillment of Course Requirements for Master's Degree* form to the CSEE Dept.

6. Students are required to maintain a minimum GPA of 3.0 (this is also a Graduate School requirement). Students who fail to maintain the minimum GPA may be subject to academic probation and in the case of repeated poor academic performance, be subject to dismissal from the graduate program.

7. A graduate-level course that counts towards the M.S. degree may be repeated at most once, if necessary.

8. Leave of absence (LOA) will be granted at most three times during the entire M.S. degree. The *LOA Request* form should be submitted before the end of the add/drop period. Requests submitted after that period may not be approved. Please consult your research advisor before submitting this form.

9. Students admitted to the B.S./M.S. program at UMBC: Up to nine graduate credits taken as an undergraduate can count towards the M.S. degree. Once you enroll in the M.S. program, please check with the Graduate Program Director to ensure that the courses taken as an undergraduate will be eligible for the M.S. degree.

3.2 TA Support and M.S. Thesis

<u>A student in the M.S. program who has been supported by the department as a regular 20-hour TA for at least three semesters is required to complete a Master's Thesis for the degree</u>. The student should register for at least three credits of M.S. Thesis (CMSC 799) in the third semester and submit a thesis abstract by the end of their third semester (as part of evidence that they plan to pursue the thesis option).

For a Ph.D. student who does not have a prior M.S. degree in computer science and has been supported by the department as a regular 20-hour TA for at least three semesters, the following options apply:

1. If the student has passed the comprehensive examination/portfolio within the specified time limit, the student can apply for a M.S. degree with either the thesis or non-thesis option.

2. If the student has failed the comprehensive examination/portfolio within the specified time limit and desires to take the terminal M.S. degree, then the student must follow the M.S. with thesis option.

3.3 M.S. Timeline/Milestones

The following list presents the milestones and deadlines for M.S. students currently in the CMSC graduate program.

1. **File the *Research Advisor* Form:** Select a research advisor by the second semester in residence and submit the form by April 15th (for students starting in the Fall semester) or Nov 15 (for students starting in the Spring semester).

   Part-time students: File the form in the semester (by April 15 or Nov 15) in which the student has completed 15 credits towards the M.S. degree.

2. **Research Abstract:** For students choosing the thesis option, submit a 1-page research abstract describing the topic, the problem that is planned to be addressed and the expected methodology of study. This should be filed by Jan. 31st for Spring graduation, May 31st for Summer graduation, and Sept. 30th for Fall graduation.

3. **Progression and Graduation Forms:** Follow all the Graduate School requirements for applying for the M.S. degree as well as departmental guidelines:

   M.S. Thesis Option

   1. *Research Advisor* form
   2. *M.S. Thesis/Project Abstract* form
   3. *Fulfillment of Course Requirements* form
   4. *Application for Diploma* form
   5. *Nomination of Members for Final Examination Committee* form

6. *Certificate of Completion of M.S. Degree Requirements* form
7. *Certificate of Completion of M.S. Thesis* form
8. Submit unbound copy of thesis to Graduate School

M.S. Non-Thesis Option

1. *Research Advisor* form
2. *Fulfillment of Course Requirements* form
3. *Application for Diploma* form
4. *Scholarly Paper Approval* form
5. *Certificate of Completion of M.S. Degree Requirements* form
6. If the student chooses to take CMSC 698, copy of the approved scholarly paper is to be submitted to the department

Important Note: If deadlines are not strictly met, you risk delaying your defense dates and/or your graduation!

4. Requirements for the Ph.D. Degree in Computer Science

The following table summarizes the requirements for the Ph.D. degree in computer science:

Summary of Requirements for the Ph.D. Degree in Computer Science
33 credits of graduate coursework, with the following mix of courses: CMSC 641 Algorithms, plus at least one from the "systems" set {CMSC 611 Computer Architecture, CMSC 621 Operating Systems, CMSC 661 Database, CMSC 681 Networks} and at least one from the "applications" set {CMSC 626 Computer Security, CMSC 634 Computer Graphics, CMSC 671 Artificial Intelligence, CMSC 678 Machine Learning}   **at most** 6 credits of some combination of CMSC 696, CMSC 699, and CMSC 898   **at most** 9 credits of non-CMSC courses with prior approval   Ph.D. students are free to take more CMSC 898 and 899, above the 33 credits required
A minimum GPA of 3.0
Passing the Comprehensive Portfolio
Passing the Preliminary Examination and Admission to Candidacy
18 credits of Dissertation Research (CMSC 899) taken after Admission to Candidacy, taken over at least two semesters (Summer semesters typically do not count)
Completing and successfully defending the Dissertation
A minimum of three years of full-time graduate study or its equivalent, with at least one year of full-time study completed at UMBC. (The 18 credits of CMSC 899 satisfy this last requirement.)
Completing each of the milestones according to the timeline specified in Section 4.5 Ph.D. Timeline/Milestones

Many of the items listed in the above table are governed by further rules and specific time requirements. These details are specified in the appropriate subsection.

4.1 Coursework Requirements

Each student must satisfy the minimum course requirements—eleven courses totaling 33 credits, excluding doctoral dissertation research credits.

Of the 33 graduate-level course credits required for the Ph.D. degree:

(a) The required courses include: CMSC 641 Algorithms, at least one from the set of "Systems" courses {CMSC 611 Computer Architecture, CMSC 621 Operating Systems, CMSC 661 Database, CMSC 681 Networks}, and at least one from the set of "Applications" courses {CMSC 626 Computer Security, CMSC 634 Computer Graphics, CMSC 671 Artificial Intelligence, CMSC 678 Machine Learning}

(b) At most 6 credits total of CMSC 699 (P/F) and/or CMSC 696 (P/F) and/or CMSC 898 (P/F) can be counted.

(c) No regular graduate course taken pass/fail (P/F) will be counted towards the 33 credits.

(d) Students who earn their M.S. degree here will acquire many if not all of these required credits.

(e) CMSC 899 credits cannot be counted towards the 33 credits. Students may register for dissertation research credits (CMSC 899) after admission to candidacy. The Graduate School requires that students who are admitted to candidacy must register for six CMSC 899 credits every semester until graduation. Under special circumstances, a student may request leave of absence during candidacy, by filling out a form obtained from the Graduate School website. A minimum of 18 credits of CMSC 899 are required for graduation; the 18 credits must be taken over at least two semesters.

(f) Students with graduate courses from other universities should submit the *Course Equivalency Request* form soon after joining UMBC, preferably before their second semester.

    Note: Such courses, if approved, are not officially transferred (i.e. they will not show up on your transcript), but will be counted towards the required Ph.D. course credits.

(g) Requests for approval of non-CMSC course credits (at most nine credits) should be submitted before registering for the non-CMSC course. There is a form available for this request and should be signed by the student's research advisor.

(h) Students are required to maintain a minimum GPA of 3.0 (this is also a Graduate School requirement). Students who fail to maintain the minimum GPA may be subject to academic probation and may be subject to dismissal from the Graduate Program in the case of repeated poor academic performance.

4.2 Comprehensive Portfolio

The comprehensive portfolio is intended to evaluate the understanding of core material and the readiness of doctoral students to pursue research. It consists of the following components:

1. Course performance
2. Research statement
3. Curriculum vita
4. An independently produced report
5. Two letters of support, one from the research mentor, one from another CSEE faculty member.

The CMSC Graduate Committee will make its decision about the student's continuation in the Ph.D. program based on evaluation of these materials. The student must submit the final portfolio before the end of the fourth semester for full-time students, or the end of the fifth semester for part-time students. Templates for the student research statement and faculty letters of support are available on the CSEE website. While it is expected that the portfolio will be strong across all areas, the portfolio will be evaluated as a whole, with excellent performance in one area possibly offsetting lower performance in another area.

Course Performance

Demonstrated strong performance in graduate coursework is important for the foundation of knowledge needed to conduct research in computer science. It is recommended that Ph.D. students achieve a minimum GPA of 3.5 in regular computer science courses.

Should the student's GPA fall below the recommended level, this performance in coursework may be offset in the review of the overall portfolio with evidence that reflects one or more of the following areas: high levels of achievement in advanced coursework, strength in the written report, demonstrated superior proficiency in preliminary research, or other evidence of potential research excellence provided by the faculty or the student in the portfolio.

For Transfer Students:

1. **For the core courses:** You may submit a request for course equivalency for courses taken at other universities (with a minimum grade of B or equivalent). If the course syllabi, exams/projects, and evaluation criteria are comparable to the UMBC course, we will consider the grade in that course in the evaluation of the course requirement portion of the portfolio.

2. **For non-core courses:** The current standard policy as outlined elsewhere in this document applies.

Written Report

The ability to analyze and synthesize ideas is critical for success in a doctoral program. All students must submit a written report on a topic approved by the research mentor. This can be a report from an independent study or independent project course, or it may come from preliminary research conducted by the student. The student must write the report independently. The report should demonstrate understanding of materials from more than one subfield in computer science and related disciplines. The student is encouraged but not required to include original results in the report.

The report can be up to 10 pages, single-spaced. It should be in double-column format with the font for the main text no smaller than 11pt. You may follow the format instruction of any major Computer Science conference for other formatting specifics. As an example, the LaTeX style file and Microsoft Word template for IJCAI are provided at the graduate website.

Submission Details

1. The completed portfolios must be submitted by January 31 or August 31.

2. *Preliminary:* Full-time students must submit a preliminary portfolio at the beginning of their third Ph.D. program at UMBC. Part-time students must submit a preliminary portfolio at the beginning of their fourth semester in the Ph.D. program at UMBC. The preliminary portfolio is not required to include the written report. The support letter from the research mentor is required, additional letters are optional. Feedback will be provided on the preliminary portfolio so that students can strengthen the final submission.

3. *Final:* Full-time students must submit the final portfolio at the beginning of their **5th semester** at UMBC. Part-time student must submit the final portfolio at the beginning of their **6th semester**.

4. **The Graduate Committee will provide one of three decisions on the final portfolio: Pass, Deficient (certain conditions will be imposed for continuation in the program), or Fail.**

5. The final portfolio can be submitted ahead of schedule.

4.3 Preliminary Examination (Prelim) and Candidacy

Each student must select a dissertation advisor and a dissertation preliminary examination committee and must pass a two-part preliminary examination. In the first part, the student will present and defend his or her dissertation proposal to the Prelim Committee. In the second part, the Committee examines the student orally on his or her research area(s) to assess his or her ability to successfully complete the proposed research.

Notes:

1. The committee must consist of at least four members, of whom three (including the Chair) must hold regular Graduate faculty status. It is also recommended that the committee have at least one member outside the student's graduate program.

2. The intent is that there will be significant overlap between members of the Ph.D. Final Dissertation Committee and the Preliminary Examination Committee.

3. The *Ph.D. Preliminary Exam Scheduling Form* must be submitted at least thirty (30) calendar days prior to the examination date. A preliminary examination held without prior submission of this form will be considered invalid and the *Application for Candidacy* will not be processed.

Ph.D. Candidacy: After passing the prelim and completing the course requirements, the Graduate Program Director recommends to the Graduate School that the student be admitted to Ph.D. candidacy. **The student should submit the relevant *Application for Candidacy* form to the department for approval and forwarding to the Graduate School.** A student who has passed the preliminary exam and has finished 30 graduate credits may apply for candidacy in the semester that they are registered for the 11th course; the application must be submitted before the 10th day of the semester.

4.4 Dissertation Research

Each student will conduct and report on a significant original research project under the guidance of his or her dissertation advisor. This research must be completed and defended within four years of admission to candidacy. Students must be admitted to candidacy at least two full sequential semesters before the date on which the doctoral degree is to be conferred.

The doctoral dissertation must be an <u>original</u> and <u>substantive contribution</u> to knowledge in the student's major field, and must demonstrate the student's ability to carry out a program of research and to report the results in accordance with standards observed in the recognized scientific journals related to that field.

Residency Requirements: A minimum of three years of full-time graduate study or its equivalent is required. At least one year of full-time study must be completed at UMBC.

4.5 Ph.D. Timeline/Milestones

The following list presents the milestones and deadlines for CMSC Ph.D. students. Failure to meet any of the deadlines could result in penalties including, but not limited to: loss of financial support, academic probation, and/or dismissal from the program.

1. **Determine Coursework:** Evaluate the course requirements and take appropriate courses in consultation with your temporary or research advisor.

   If you already have an M.S. degree from elsewhere, determine which courses can be counted towards the Ph.D. degree course requirements and apply for formal course-equivalency credits.

2. **Research Experience Evidence:** By the end of the second semester in residence (May 31 for students who started in the Fall and Dec 31 for Spring starts), the student should submit: (i) a research statement outlining the student's research activities in the first year; and (ii) a statement of support from a faculty member potentially interested to be the student's research advisor. The research experience can be obtained by registering for at least 3 credits of CMSC 699 with a faculty member and/or working on research publications.

   Satisfactory evidence of research, strong academic performance and positive TA evaluations are some of the prerequisites for continued departmental TA support

in the second and subsequent years.

3. **Portfolio:** Successfully pass the portfolio by the end of the fourth semester in residence (fifth semester for part-time students). You are allowed at most two attempts within this specified time limit. For those who started prior to Fall 2005 and plan to take the examination model, these examinations are typically offered in the week before classes start.

4. **File the *Research Advisor* Form:** Select a research advisor by the fourth semester in residence and submit the form by April 15th (for students starting in the Fall semester) or Nov 15 (for students starting in the Spring semester).

5. **Research Progress Form:** After passing the comprehensive exam or final comprehensive portfolio, file a *Research Progress* form by April 15th each year until graduation. This report is for the period covering April 1st of the preceding year until March 30th of the current year. This includes a CV, research projects involved in, publications submitted or accepted, conferences attended/presented, awards received, etc. The progress form will also include a brief statement from the research advisor on the student's research progress.

6. **Preliminary Examination/Admission to Candidacy:** Successfully pass the Ph.D. Preliminary exam by the end of the fourth year (fifth year for part-time students) after starting the Ph.D. program. **The preliminary examination may be attempted only after approval of the final portfolio**. The *Preliminary Exam Committee Nomination* form should be filed at least 30 days prior to the prelim exam. The *Preliminary Examination Scheduling Form* must be submitted to the Graduate Program Director at least 30 days prior to the examination date.

    After completing the 33 credits of graduate coursework required for the Ph.D. degree and passing the Ph.D. Preliminary Examination, the student must apply to the Graduate School for *Admission to Candidacy*. Once admitted to candidacy, the student must register for 6 credits of CMSC 899 each semester until graduation, unless leave of absence is granted (see above).

    Now you have attained the so-called *All But Dissertation* (ABD) stage.

4. **Research Progress Form:** Continue to file the *Research Progress* form by April 15th each year until graduation.

5. **Final Dissertation Defense:** Successfully pass the Ph.D. dissertation defense after at least two semesters and within four years of passing the Preliminary exam.

6. **Graduate School Forms:** Follow all the Graduate School requirements for applying for the Ph.D. degree:

    (a) *Nomination of Members for the Final Doctoral Examination Committee* (at least six months prior to final Ph.D. examination)

    (b) Announcement of Ph.D. Dissertation Defense (ten working days prior to Ph.D. defense date)

    (c) *Certification of Completion of Doctoral Dissertation* form

        (d) *Application for Diploma* form

Important note: If the above deadlines are not strictly met, you risk delaying your defense date and/or graduation.

5 What I Wish I Had Known: Advice from Fellow Students

This section contains recommendations and information on a variety of topics regarding the CS graduate program. It was written for students by students, and contains information that enhances and supports material elsewhere in this program handbook. These recommendations are only guidelines, and do not reflect additional program requirements or CSEE policies.

5.1 Forms and Deadlines

Advance Form Due Dates by 1-2 Weeks: Most graduate school forms require the signature of the CMSC Graduate Program Director before they can be submitted. Obtaining this signature may take up to a week, so to avoid the graduate school forms being late, you must advance all due dates by 1-2 weeks. These due dates are listed on the graduate school website: www.umbc.edu/gradschool.

We also recommend advancing the due dates of the CSEE department forms by 1 week, however, you can submit them closer to the deadline provided that you have already obtained all other signatures.

Forms that require the signature of the GPD (currently Professor Nicholas) may be presented during regular office hours, or given to the CMSC Graduate Program Coordinator, Mrs. Keara Fliggins.

5.2 Research and Lab Rotations

Start Research Immediately: We highly recommend that students work on research projects beginning with their first semester. You may get formal credit for these research projects by registering for CMSC 699 Independent Study/Research.

Rotate through Several Labs: Many other graduate programs contain a research rotation that rotates first or second year Ph.D. students through two or three different research labs. This research rotation provides an invaluable chance to see how different labs work, interact with several professors, and gain exposure to a variety of areas.

Although there is no formal "research rotation" in place for the CS graduate program, we recommend taking 2-3 semesters of CMSC 699 and working with a **different** professor (in different labs) during **at least** two of those independent studies.

Although this limits the length of the independent study projects to a single semester, you will find the exposure helpful in your future research and in selecting an advisor. The knowledge of multiple CS subfields also encourages your research to be interdisciplinary.

You may also learn about other lab's research and work your way into a lab by attending the regular lab meetings, which are generally open to visitors. We recommend you attend several labs' meetings early in your graduate career.

Attending lab meetings is a good way of learning an area of computer science, and of getting to know research-active faculty. Working on projects in the various labs, whether for credit or not, makes the student better prepared to accept and perform the duties of research assistant (RA) positions.

Stay Current in the Field: We also highly recommend attending several department research colloquia each semester and browsing conference and journal publications through the UMBC library's Research Port website to stay current with other CS research. We also recommend beginning to review conference and journal publications as soon as possible. Your advisor has many organizations asking them to review publications, and you should keep asking your advisor to let you review several publications each semester. This is a great way to learn about the publication process, learn how to get your research published, and enhance your curriculum vitae.

5.3 Socializing

Build a Social Network: It is vital to build and maintain a social network in the department and with other researchers in your field. Your contacts (especially with people outside the department) are very important for fostering research collaboration. Contacts within your department are important for immediate feedback on your research and for support during your graduate career.

Work in a Social Environment: It is very important for full-time students, especially Ph.D. students, to work on-campus and in the department. This also gives yourself and others opportunities to work together to understand concepts, and solve class or research problems. Such impromptu collaboration cannot be planned. Students that work in a social environment have a much higher success rate than those who work in isolation.

Serve on Committees: The more you "stick your neck out" and get your name around, the more likely that a faculty member will recommend you for service on department committees (such as the Promotions and Tenure committee, the Graduate committee, hiring committees, etc.), which will improve your curriculum vitae.

Attend Department Social Events: Attending department social events is another good way of making contacts within the department. It is also a good way of breaking the isolation of research.

Attend Conferences: The primary way to make contacts with other researchers in your field is by attending conferences. The Graduate Student Association provides funds for graduate students to attend conferences. Additionally, many conferences have student scholarships that you can apply to for travel funding. We recommend that students attend conferences whenever they have the chance to do so, and spend a good portion of their time at the conference meeting researchers in their area. As a result of the ongoing public

health crisis, many conferences are hybrid or entirely online, and as a result offer substantial registration discounts.

5.4 Fellowships and Internships

Apply for Fellowships: Fellowships provide a much more flexible method of funding than department assistantships, and are highly prestigious. During the first several years of your graduate study, you are eligible to apply to many of the fellowship programs. We recommend that you keep applying for fellowships as long as you are eligible.

Do Internships: Internships provide a great way to gain practical on-the-job experience, make industry contacts for future employment, and earn extra money. There are many internships in computer science that are available for either the summer months or longer periods of time extending into the semester.

Most TA-ships do not extend into the summer, so summer internships provide funding for the summer and allow you to save money for the school year.

Apply Early to Internships: If you are interested in a summer internship, you should apply for it the previous Fall semester. For most government internships that may require security clearance, you need to begin applying one year in advance.

5.5 Progress Checklists

Use the CMSC Program Checklists: The CS department website includes checklists for each CS graduate program to track your progress. Print out and keep the appropriate progress checklist up-to-date – it will save you stress and help you graduate on-time!

5.6 Academic Integrity

UMBC and the CSEE Department take academic integrity very seriously. We discuss this topic during graduate student orientation, and in our various classes. In short, work that you submit for credit needs to be *your* work.   We of course encourage students to use the scholarly literature. However, quoting or paraphrasing such material without giving the author due credit is plagiarism, and is a form of academic honesty. Your instructor can give you guidance on what is and is not acceptable for specific assignments. For more general guidance, we invite you to review the ACM Code of Ethics, and the MIT Academic Integrity Handbook.

6 Facilities and Special Resources

The department's computing facilities workstations and server-class machines. The

UMBC Office of Information Technology has workstations for general student use and several high--end machines. UMBC's Imaging Research Center also provides high-end- graphics support including production quality input/output devices and production software (Wavefront, Softimage, and Alias).

Center for Information Security and Assurance

Cyber Defense Lab

Contact: Dr. Alan Sherman

The Cyber Defense Lab focuses on research related to computer systems security, cryptology, intrusion detection, and electronic commerce. It provides an isolated environment where students are provided a unique opportunity to research topics that would ordinarily be considered too dangerous to network and system resources to be investigated in other computer labs.

CORAL (COgnition, Robotics, And Learning) Laboratory

Contact: Dr. Tim Oates

Research in the Cognition, Robotics, and Learning (CORAL) lab seeks to understand how artificial systems can acquire grounded knowledge from sensori-motor interaction with their environment that enables cognitive activities, such as natural language communication and planning.

URL: https://coral-lab.umbc.edu/

Computer Vision Lab

Contact: Dr. Hamed Pirsiavash

The Computer Vision Lab focuses on research to make computer vision algorithms and models robust, interpretable and learn from limited data. Research themes include Adversarial Machine Learning, Model Interpretability, Self-Supervised Learning, Domain Adaptation, Meta-Learning, Few-Shot Learning and more. The Lab has a strong team of graduate students who strive to publish at top conference venues. The Lab's research is supported by government and corporate sponsors and partners that include DARPA, NSF, NIST, SAP SE and Northrop Grumman.

URL: https://cv-lab.umbc.edu/

Data & Resource Engineering and Management (DREAM) Lab

Contact: Dr. Konstantinos Kalpakis

The mission of the DREAM Lab is to design algorithms and develop system architectures for the engineering of data systems and the management of distributed computing system resources. Research themes include managing and mining spatio-temporal multimedia scientific datasets, data replication and query processing, resource management in distributed systems, sensor networks, streaming datasets, and system security.

Discovery, Reverse Engineering and Analysis of Malware (DREAM) Lab

Contact: Dr. Charles Nicholas

The Malware Research group explores the intersection between data science and cybersecurity, with an emphasis on machine learning applications in the field of malware analysis on a large-scale. We are interested in problems such as clustering of malware into families, detection of malware in otherwise benign systems, and evaluation of malware detection systems. These two DREAM Labs share ITE 366.

The eBiquity Group

Contacts: Drs. Tim Finin, Anupam Joshi, and Yelena Yesha

The eBiquity Group studies the interactions between mobile and pervasive computing, the semantic web, cognitive systems and security. It includes over 20 students conducting research and pursuing graduate or undergraduate degrees. Research is characterized by fundamental advances in underlying areas -- distributed systems, wireless networking, databases technology, multiagent systems, knowledge representation and reasoning, machine learning, and security -- explored and evaluated through their application to problems that matter. The eBiquity groups' research is supported by corporate and government sponsors and partners that include NSF, DARPA, NASA, NIST, DoD, IBM, HP, Fujitsu, Nokia, and AetherSystems.

URL: http://ebiquity.umbc.edu/

VANGOGH Laboratory
Visualization, Animation, Non-Photorealistic Graphics, Object-Modeling,
and Graphics Hardware

Contacts: Marc Olano

The VANGOGH laboratory provides a specialized environment for research in computer graphics. The pillars of the lab are understanding of data using visualization and

interactive graphics using graphics hardware. Between these two areas, the VANGOGH lab fosters research in realistic and non-realistic artistic graphics, procedural shading, computer animation, object modeling and representation, and design and use of graphics hardware. Research in the VANGOGH laboratory has been supported by ARDA, NSA and NSF.

URL: www.cs.umbc.edu/gavl.

7. Listing of CMSC Graduate Courses

Some of the courses listed below are offered frequently, and others are taught rarely if ever. The frequencies of offering, as listed, are based on recent history and are not binding on the program. They may be useful for planning.

Different sections of CMSC 691 may be taken, with each counting towards the MS or PhD degrees as separate courses. The UMBC Schedule of Classes can be examined to see what has been offered in the recent past, and (hence) what will likely be offered in the near future.

CMSC 601 Research Skills for Computer Science

Credits: 3 Offered: Rarely

In this course, students will learn basic skills that are essential to becoming a successful researcher. The objective of the course is to teach research skills in a systematic fashion, early in a student's graduate program. The core of the course is a structured, supervised research project on a topic of the student's choice. Additional lecture topics include writing skills, research methodology, experimental design, career options, professional ethics and academic integrity, and oral and written presentation techniques.

Pre-requisite: Graduate Standing in Computer Science.

CMSC 603 Advanced Discrete Structures

Credits: 3 Offered: Rarely

Introduction to the fundamental concepts and techniques of discrete mathematics that are essential for the study of computer science. The main goal of this course is to develop mathematical skills and sophistication for proving theorems, solving problems, and counting and approximating values. Topics include sets; elementary logic; numbers; functions and relations; summations; generating functions; elementary number theory; elementary probability, statistics, and combinatorics (e.g. Burnside's Lemma); introduction to algebraic systems, including groups; and applications of these topics in computer science.

Prerequisites: MATH 152, MATH 221, and at least one math course beyond linear algebra.

CMSC 611 Advanced Computer Architecture

Credits: 3 Offered: every semester

Memory system design, pipeline structures, vector computers, scientific array processors, multiprocessor architecture. Within each topic, the emphasis is on fundamental limitations: memory bandwidth, inter-processor communication, processing bandwidth, and synchronization.

Prerequisite: CMSC 411 or permission of instructor.

Revised 5/11/2021

CMSC 615 Introduction to Systems Engineering

Credits: 3 Offered: Rarely

The course provides an introduction to Systems Engineering for students with a background in information technology. It introduces Systems Engineering activities, artifacts and milestones as well as key Systems Engineering-related references and tools. Although the course focuses principally on Requirements Elaboration and Analysis, Design Synthesis and Architecture Modeling (DOD Architecture Framework, Structured Analysis, UML and SysML) and Requirements Document Development and Traceability, other topics include: Life Cycle Models, DoD Acquisition Process, Systems Engineering Process, Quality Management, Systems Engineering Planning and Team Building, Configuration Management, Risk Management, Technical Performance Measures, Analysis and Simulation, Design and Development, Verification, Validation and Testing.

CMSC 618 Implementation, Integration and Test

Credits: 3 Offered: Rarely

Same as: ENEE 663 – System Implementation, Integration and Test

CMSC 621 Advanced Operating Systems

Credits: 3 Offered: Every semester

A detailed study of advanced topics in operating systems including: synchronization mechanisms, virtual memory, deadlocks, distributed resource sharing, computer security, and modeling of operating systems.

Prerequisite: CMSC 421 or permission of instructor.

CMSC 625 Modeling and Simulation of Computer Systems

Credits: 3 Offered: Rarely

Performance evaluation methods, Markovian queuing models, open networks of queues, closed product form queuing networks, simulation and measurement of computer systems, bench marking, and workload characterization.

Prerequisite: CMSC 411 or CMSC 421, or permission of instructor.

CMSC 626 Principles of Computer Security

Credits: 3 Offered: once a year

This course will provide an introduction to computer security, with specific focus on the computing aspects. Topics covered will include: Basics of computer security including an overview of threat, attack and adversary models; social engineering; essentials of cryptography; traditional computing security models; malicious software; secure

programming; Operating system security in practice; trusted operating system design; public policy issues including legal, privacy and ethical issues; network and database security overview.

Prerequisite: CMSC 421 or permission of instructor

CMSC 627 Wearable Computing

Credits: 3 **Offered: Rarely**

This course covers fundamental concepts, methodologies, algorithms and the research challenges related to wearable computing, including the following: Emotional Design, Convergent Design Processes, Wearability Considerations, Wearable Sensors Networks, Wearable Networks, Physiological Wearable Sensors, Innovation processes, Marketing and business considerations, Human Aware Computing, Context Awareness, Wearable Communities, Future Mobility and Wearable Systems Applications.

Pre-requisite: Graduate Standing in Computer Science or permission of instructor.

CMSC 628 Introduction to Mobile Computing

Credits: 3 **Offered: once a year**

This course will introduce students to the techniques and research issues involved with mobile computing, which deals with access to the networked information and computation resources from wirelessly connected palmtop/laptop type devices. Topics covered deal with both networking (MAC protocols, ad-hoc routing, mobile IP) and data management (proxy-based systems, mobile DBMS, mobile transactions, sensor networks and stream data) issues.

CMSC 631 Principles of Programming Languages

Credits: 3 Offered: Rarely

A comparison of three types of modern programming languages: assertive, functional, and logic based. Fundamental semantic methods, including operational, axiomatic, and denotational semantics and corresponding techniques for program verification, including Hoare's logic, Dijkstra's predicate transformers, and denotational methods.

Prerequisite: CMSC 331 or permission of instructor.

CMSC 634 Computer Graphics

Credits: 3 Offered: once a year

An introduction to the fundamentals of interactive computer graphics. Topics include graphics hardware, line drawing, area filling; clipping, two-dimensional and three-dimensional geometrical transforms, three-dimensional perspective viewing, hidden surface removal, illumination, color and shading models.

Pre-requisite: Graduate Standing in Computer Science or permission of instructor.

Revised 5/11/2021

CMSC 635 Advanced Computer Graphics

Credits: 3 Offered: once a year

A study of advanced topics in computer graphics emphasizing algorithms for display of 3D objects including: wire frame representation, polygon mesh models, shading algorithms, parametric representation of curves, hidden surface elimination, fractals, and ray tracing. Other topics include: advanced topics from the computer graphics literature, page description languages, CORE, GKS, PHIGS, CGI, the X window system, X window intrinsics, Motif and widget programming.

Prerequisite: CMSC 435 or permission of instructor.

CMSC 636 Data Visualization

Credits: 3 Offered: Sometimes

This course addresses the theoretical and practical issues in creating visual representations of large amounts of data. It covers the core topics in data visualization: data representation, visualization toolkits, scientific visualization, medical visualization, information visualization, and volume rendering techniques. Additionally, the related topics of applied human perception and advanced display devices are introduced. Open to computer science students with a background in computer graphics or students in data-intensive fields who are familiar with the use of the computer for data collection, storage, or analysis.

Prerequisites: CMSC 435, CMSC 634, or permission of instructor.

CMSC 641 Design and Analysis of Algorithms

Credits: 3 Offered: Every semester

Fundamental algorithms, mathematical tools for analyzing algorithms, and strategies for designing algorithms. Topics include graph algorithms (including network flow), parallel algorithms, and algorithms for selected combinatorial tasks. Tools include asymptotic notations, recurrences, amortized analysis, and probabilistic analysis. Strategies include divide and conquer, greedy, dynamic programming, time space tradeoff, and randomization. Introduction to NP completeness.

Prerequisite: CMSC 441 or permission of instructor.

CMSC 643 Quantum Computation

Credits: 3 Offered: once a year

The course begins with a brief overview of those topics in quantum mechanics and mathematics needed for the understanding of quantum computation. It will then focus

on quantum algorithms, covering such topics as quantum superposition and quantum entanglement, quantum decoherence, quantum teleportation, quantum Turing machines, Shor's Algorithm, Grover's algorithm, Hallgren's algorithm, quantum information theory, quantum data compression, quantum cryptographic protocols, quantum error-correcting codes, implementation issues. Various research level problems will be discussed.

Prerequisite: CMSC 641 or CMSC 651 or permission of instructor.

CMSC 644 Information Assurance

Credits: 3 Offered: Sometimes

Selected recent research topics in information assurance, such as social engineering, buffer overflow, malicious code, spyware, intrusion detection, firewalls, denial of service, information warfare, computer forensics, recovery and response, enterprise security, clandestine channels and emissions security, security analysis, security models and formal techniques, best practices, and national policy for information assurance.

CMSC 645 Advanced Software Engineering

Credits: 3 Offered: Sometimes

Modern approaches to software development: Requirements analysis, system design techniques, formal description techniques, implementation, testing, debugging, metrics, human factors, quality assurance, cost estimation, maintenance, and tools.

Prerequisite: CMSC 445 or permission of instructor.

CMSC 651 Automata Theory and Formal Languages

Credits: 3 Offered: once a year

Formal languages and their corresponding classes of automata: regular languages and finite automata, context free languages and pushdown automata, context sensitive languages and linear bounded automata, recursively innumerable sets, and Turing machines. Also, pumping lemmas, closure properties, and decision problems for various classes of languages. Other sorts of automata may be studied, including multi headed automata, probabilistic automata, and Petri nets.

Prerequisite: CMSC 451 or permission of instructor.

CMSC 652 Cryptography and Data Security

Credits: 3 Offered: Sometimes

Conventional and public key cryptography. Selected crypt systems, including DES and RSA. Digital signatures, pseudo-random number generation, cryptographic protocols, and cryptanalytic techniques. Applications of cryptography to electronic commerce.

Prerequisites: CMSC 441 and MATH 221 or permission of instructor.

CMSC 653 Coding Theory and Applications

Credits: 3 Offered: Sometimes

An introduction to the theory of error correcting codes with an emphasis on applications and implementations. Shannon's theorems, bounds on code weight distributions, linear codes, cyclic codes, Hamming and BCH codes, linear sequential circuits, encoding/decoding algorithms. Other topics may be drawn from Goppa, ReedSolomon, QR codes, nonlinear codes, and convolutional codes.

Prerequisite: CMSC 203 or MATH 221, or permission of instructor.

CMSC 655 Numerical Computations

Credits: 3 Offered: Sometimes

Numerical algorithms and computations in a parallel processing environment. The architecture of supercomputers, vectorizing compilers and numerical algorithms for parallel computers.

Prerequisites: CMSC 411 and Math 221, or permission of instructor.

CMSC 656 Symbolic and Algebraic Processing

Credits: 3 Offered: Sometimes

Applications and Foundations of Symbolic Algebra. Applications and examples are studied using at least one large symbolic algebra package. Symbolic algebra combines elements of AI, analysis of algorithms, and abstract algebra. Foundations include problems of representation, canonical and normal forms, polynomial simplification, Buchberger s algorithm, g.c.d. in one and several variables, panic methods, and formal methods for integration.

Prerequisites: CMSC 203 and CMSC 341 or permission of instructor.

CMSC 657 Networks and Combinatorial Optimizations

Credits: 3 Offered: Rarely

Graph theoretic concepts, unimodular matrices, transportation problems, minimum cost network flows, maximal flows in networks, shortest path algorithms, spanning three problems, multi-commodity flows and decomposition algorithms, assignment and matching problems, computational complexity of algorithms, and other special topics such as matroid theory and nonlinear network minimization.

Prerequisite: CMSC 641 or permission of instructor.

CMSC 661 Principles of Database Systems

Credits: 3 Offered: once a year

Advanced topics in the area of data base management systems: data models and their underlying mathematical foundations, data base manipulation and query languages, functional dependencies, physical data organization and indexing methods, concurrency control, crash recovery, data base security, and distributed data bases.

Prerequisite: CMSC 461 or permission of instructor.

CMSC 665 Introduction to Electronic Commerce

Credits: 3 Offered: Rarely

This course focuses on the use of electronic means to pursue business objectives. Special emphasis is placed on the student's ability to do research into existing and emerging technology and to clearly summarize and present his/her findings. The first part of the course is devoted to enabling technologies including an introduction to business models for e-commerce and basic infrastructure, an overview of networking technologies and their impact on e-commerce, and discussions on database technologies and Web-database connectivity. The second part of the course concentrates on the issues that are not solely technical such as trust management, privacy and personalization, selling information products and copy protection, and the digital divide.

CMSC 666 Electronic Commerce Technology

Credits: 3 Offered: Rarely

This course is designed to prepare students to be e-commerce developers. It introduces the students to the changing and competitive landscape of e-commerce technology, products, and solutions. The course begins with an introduction to WWW technology, an overview of Web applications and services, and discussions on networking technologies with the view towards mobile and wireless commerce and object orientation and Web programming. It also covers Java language and relational databases, database-web connectivity, inter-process communications in a distributed environment concentrating on Java RMI and CORBA technologies, JavaScript, dynamic HTML, XML and its applications, component programming with JavaBeans, and WebServer servlet architecture. The second part of the course explores the theoretical underpinnings of decision support systems, provides an overview of Web mining and commercial decision support products for E-Commerce, and introduces the student to agent technology and agent-driven e-commerce.

CMSC 671 Principles of Artificial Intelligence

Credits: 3 Offered: once a year

A study of topics central to artificial intelligence, including logic for problem solving-, intelligent search techniques, knowledge representation, inference mechanisms, expert systems, and AI programming.

Prerequisite: CMSC 471 or permission of instructor.

CMSC 673 Introduction to Natural Language Processing

Credits: 3 Offered: once a year

Natural language processing (NLP) was the first non-numerical application of computing over 50 years ago. The ultimate goal of NLP is to enable computers to communicate with people the same way as people communicate among themselves; that is, using a natural language like English. To do so, the computers must be able to understand and generate texts. The course will introduce the students to the fundamental problems, basic methods and the most important application of NLP.

Prerequisite: CMSC 313, knowledge of LISP or permission of instructor.

CMSC 675 Introduction to Neural Networks

Credits: 3 Offered: Rarely

A comprehensive study of fundamentals of neural networks. Topics include feedforward and recurrent networks, self-organizing networks, and thermodynamic networks; supervised, unsupervised, and reinforcement learning; and neural network application in function approximation, pattern analysis, optimization, and associative memories.

CMSC 676 Information Retrieval

Credits: 3 Offered: once a year

This course is an introduction to the theory and implementation of software systems designated to search through large collections of text. This course will have two main thrusts. The first is to cover the fundamental of IR: retrieval models, search algorithms, and IR evaluation. The second is to give a taste of the implementation issues through the construction and use of a text search engine.

Prerequisite: CMSC 341

CMSC 677 Agent Architecture and Multi-Agent Systems

Credits: 3 Offered: Rarely

Fundamental techniques for developing intelligent agents and multi-agent systems, including cognitive, logic-based, reactive, and belief-desire-intention architectures; inter-agent communication languages and protocols; distributed problem solving, planning and constraint satisfaction methods; distributed models and rational behavior; and learning and adaptation in multi-agent systems.

Prerequisite: CMSC 671 or permission of instructor.

CMSC 678 Machine Learning

Credits: 3 Offered: Every semester

This course will cover fundamental concepts, methodologies, and algorithms related to machine learning, including the following: decision trees, perceptrons, logistic regression, linear discriminant analysis, linear and non-linear regression, basis functions, support vector machines, neural networks, genetic algorithms, reinforcement learning, naive Bayes and Bayesian networks, bias/variance theory, ensemble methods, clustering, evaluation methodologies, and experiment design.

Prerequisite: CMSC 471 or 671, or permission of the instructor

CMSC 679 Robotics

Credits: 3 Offered: once a year

This course will cover fundamental concepts, methodologies, and algorithms related to autonomous mobile robotics, touching on mechanical, motor, sensory, perceptual, and cognitive aspects of the problem of building robots that move about and decide what to do on their own. Specific topics covered include legged and wheeled location, kinematic models and constraints, mobile robot maneuverability, motion control, sensors and sensing, perception, localization, belief representations, map representations, probabilistic map-based localization, autonomous map building, planning, reacting, and navigation architectures.

Prerequisite: CMSC 471 or 671, or permission of the instructor

CMSC 681 Advanced Computer Networks

Credits: 3 Offered: once a year

In-depth coverage of fundamental and advanced concepts in computer networking: Protocol design, verification and testing; Medium access protocols for next generation networks; Error detection and correction schemes; Distributed routing algorithms concepts and mathematical analysis; switching architectures, Quality-of-service architectures; admission control and scheduling algorithms; flow and congestion control; multicast architectures and protocols; network security; data compression.

Prerequisite: CMSC 481 or approval of instructor.

CMSC 682 Networking Technologies

Credits: 3 Offered: Sometimes

Topics in networking technologies, including ISDN, ATM/B-ISDN, frame relay, SDS, routing protocols, IP security, mobile-IP, network management, IP switching, IP/ATM integration and wireless protocols.

Prerequisite: CMSC 681 or permission of instructor.

CMSC 683 Computer Network Architecture

Credits: 3 Offered: Rarely

This course deals with various aspects of computer network architectures including architectural design, routing and transport protocols, gateway design, flow control and congestion control mechanisms, network security, Internet Architecture and protocols, and converged networks and architectures.

Prerequisite: CMSC 481 or CMSC 621 or permission from instructor.

CMSC 685 Optical Network Architectures and Protocols

Credits: 3 Offered: Rarely

Optical wavelength division multiplexed (WDM) Networks: basic optical devices, optical LANs and multiple access protocols, optical switching architectures, optical WANs and wavelength routed networks, virtual topology design, routing protocols and algorithms, wavelength conversion, protection and restoration mechanism, grooming, test beds; protocol performance analysis tools.

Prerequisite: CMSC 681 or permission of instructor.

CMSC 687 Introduction to Network Security

Credits: 3 Offered: once a year

The objective of this course is to teach the fundamental concepts, architectures and protocols related to network security. Topics covered include: Overview of network security; Basics of cryptography; Threat models; Authentication and Authorization Mechanisms and Standards; Public Key Infrastructure; Electronic Mail Security; Network layer security; Transport layer and web security; Packet Filtering, Firewalls, Intrusion Detection, and Virtual Private Networks; Recent topics in Network Security.

Prerequisite: (CMSC 341 and CMSC 481) or permission of instructor

CMSC 691 Special Topics in Computer Science

Credits: 1-3 Offered: Every semester

A set of CMSC 691 courses, on various Computer Science specialized topics, are typically offered each semester.

CMSC 696 Independent Study for Interns and Co-op Students

Credits: 1-3 Offered: every semester

One-on-one instruction of the student on practical aspects based on internship/co-op activities. A technical report, that describes the activities conducted, relevance to theoretical concepts learned in other coursework and lessons gained, is required at the end of the course. The course grade will be based on the technical report. The report will be submitted to the CMSC Graduate Program Director by the last day of final exams.

Variable credit. For each student, credit established based on level of effort required from student and length of internship/coop.

Prerequisite: Must have completed at least 6 graduate level CMSC credits at UMBC.

The course may be repeated, but credit towards the degree will be based on following policy:

  (i) A combined TOTAL of 3 Credits between CMSC 696/CMSC 699 may be applied toward the M.S. degree in Computer Science.

  (ii) A Combined TOTAL of 6 Credits between CMSC 696/CMSC 699/CMSC 800/CMSC 898 may be applied towards the Ph.D. degree in Computer Science.

CMSC 698 Research Project in Computer Science

Credits: 1-3 Offered: Every semester

Individual project on a topic in computer science. The project will result in a scholarly paper, which must be approved by the student's advisor and read by another CSEE faculty member. Required of non-thesis M.S. students.

NOTE: May be taken for repeated credit up to a maximum of three credits.

Prerequisite: Completion of breadth courses or consent of the advisor.

CMSC 699 Independent Study in Computer Science

Credits: 1-3 Offered: Every semester

Independent Study work will consist of individualized research work with a faculty member.

CMSC 721 Theory of Processes

Credits: 3 Offered: Never

Formal approaches to the theory of communicating systems of processes, and logical systems for reasoning about them. Specific systems may include Milner's calculus of

communicating systems (CCS), Hoare's communicating sequential processes (CSP), and Kahn's applications of fixpoint theory to communicating processes.

Prerequisite: CMSC 621 or CMSC 631 or CMSC 681, or permission of instructor.

CMSC 731 Semantics of Programming Languages

Credits: 3 Offered: Rarely

The fundamentals of axiomatic and denotational semantics, together with their corresponding techniques for program specification and verification. Axiomatic methods include Hoare's logic and Dijkstra's predicate transfer-MES. Denotational methods include fixpoint theory and an introduction to the lambda calculus. Denotational methods are used to prove the soundness of selected axiomatic proof rules.

Prerequisite: CMSC 631 or permission of instructor.

CMSC 741 Theory of NP Completeness

Credits: 3 Offered: Rarely

An in-depth- study of the classes P and NP, along with the concepts of reducibility and completeness. NP complete problems are surveyed, and reduction techniques are examined in greater detail. An important goal is to develop skill at proving problems NP complete.

Prerequisite: CMSC 641 or permission of instructor.

CMSC 742 Parallel Algorithms and Complexity

Credits: 3 Offered: Rarely

Models of parallel computation and methods for the representation of parallel algorithms are presented. Measures of parallel complexity, and techniques for analyzing algorithms with respect to these new measures, and parallel complexity classes, such as NC, are studied.

Prerequisite: CMSC 641 or permission of instructor.

CMSC 743 Quantum Information Science

Credits: 3 Offered: Rarely

This course will begin with a brief review of quantum mechanics. It will then focus on quantum communication and quantum information, covering such topics as quantum noise and decoherence, quantum process tomography. Quantum error correction, quantum entropy, the Holevo bound, quantum data compression, quantum information over quantum channels, entanglement as a physical resource, and advanced quantum cryptographic protocols. Various research-level problems will be discussed.

Prerequisite: CMSC 641; or 643; or 651; or 656; or permission of instructor.

CMSC 751 Theory of Computation

Credits: 3 Offered: Rarely

Formal models of computation, such as Turing machines, RAM models, and loop languages are all shown to computer the class of partial recursive functions, leading to the Church Turing thesis. Basic recursive function theory, including universal functions, undecidable problems, and properties of recursive and r.e. sets. Basic concepts of first order- logic and their relationship to recursion theory. Topics in advanced recursion theory may include abstract complexity theory, oracles, the arithmetic hierarchy, and priority methods.

Prerequisite: CMSC 651 or permission of instructor.

CMSC 761 Theory of Relational Databases

Credits: 3 Offered: Rarely

An in-depth study of relational data base theory. Topics include first-order logic, relational calculus and algebra, query languages, query optimization, functional and multi-valued dependencies, normal forms, and concurrency control.

Prerequisite: CMSC 661 or permission of instructor.

CMSC 771 Heuristics and Knowledge Representation

Credits: 3 Offered: Rarely

An in-depth study of two topics central to artificial intelligence: heuristics and knowledge representation. Topics in heuristics will include the use of heuristics in problem solving, heuristic search techniques, the admissibility of heuristic search algorithms, performance analysis of heuristic methods, and heuristics for game playing. Topics in knowledge representation will include predicate calculus, frame representations, semantic nets, and inheritance.

Prerequisite: CMSC 671 or permission of instructor.

CMSC 781 Distributed Computing

Credits: 3 Offered: Rarely

Topics central to the design of distributed computing systems including distributed synchronization and resource sharing, concurrency control in distributed data bases, distributed simulations, languages for distributed computing, proof techniques for distributed systems, and distributed operating systems.

Prerequisites: CMSC 621 and CMSC 681, or permission of instructor.

CMSC 791 Graduate Seminar

Credits: 3 Offered: Sometimes

CMSC 799 Master's Thesis Research

Credits: 1-6 Offered: Every semester

This course is for students in the CMSC Master's Program engaged in master's thesis research; may be taken for repeated credits, but only a maximum of 6 credit hours applied toward M.S. thesis option requirements.

Prerequisite: Open only to CMSC thesis option students.

CMSC 891 Advanced Special Topics in Computer Science

Credits: 3 Offered: Sometimes

CMSC 898 Pre-Candidacy Doctoral Research

Credits: 1-3 Offered: Every semester

This is for graduate students who have finished all coursework but have not yet been admitted to candidacy.

CMSC 899 Doctoral Dissertation Research

Credits: 6 Offered: Every semester

This is the dissertation research course for Ph.D. students who have been admitted to candidacy; may be taken for repeated credits (minimum of 2 semesters required), but only a maximum of 18 credit hours are applied towards Ph.D. requirements. Ph.D. students admitted to candidacy are required to register for six credits of CMSC 899 every semester until graduation, unless requesting leave of absence.

8 Computer Science Faculty

A listing of the CSEE faculty and their research interests may be found at https://www.csee.umbc.edu/people/faculty/