

COMPUTER SCIENCE, BS

Computer science is the study and design of computer systems, networks, software, and computing techniques. But more importantly, it is a dynamic field with a growing impact on the world today. A report on Science, Technology, Engineering and Math (STEM) from the Georgetown University Center on Education and the Workforce (<http://cew.georgetown.edu/STEM>) forecasts 51% of STEM occupations will be computer occupations by 2018.

Concentrations

- Artificial Intelligence
- Programming Language Design and Implementation
- Software Engineering
- Computer Networking
- Algorithm Design

Research

Work with faculty (<http://uwm.edu/engineering/classification/faculty/computer-science>) engaged in leading-edge research in areas such as:

- Object-oriented programming
- Cryptography
- Computational robotics
- Intelligent dialog systems
- Artificial intelligence
- Extensible languages

Career Paths

Computer Science opens up a multitude of career options with great income potential within both the public and private sectors.

- Software Engineer
- Systems Integration Consultant
- Information Technology Manager
- Game Developer
- Application Developer/Programmer
- Data Analyst

Accreditation

The computer science program is accredited by the Computing Accreditation Commission of ABET, 415 N. Charles Street, Baltimore, MD 21201, (410) 347-7700.

New Freshmen

Admission to the College of Engineering and Applied Science is based on an overall assessment of both academic and non-academic qualifications. The primary review factors for admission are the strength and quality of the high school curriculum, high school class percentile, grade point average, and the result of the ACT or SAT. Well-prepared freshman applicants will have four years of mathematics (including one-and-a-half years of algebra, one year of geometry, and one-half year of trigonometry) and four years of natural science (including biology, chemistry, and physics). The College also will consider non-academic qualifications such as leadership skills, diversity in personal background, work experience, motivation, and maturity.

Freshmen applicants will be considered for admission directly to the major or to the First-Year Program. Admission directly to the major is selective.

Transfer Students

Transfer student admission is based on an overall assessment of both academic and non-academic qualifications. For transfer applicants, the primary factors considered for admission are the grade point average on transferable courses and the level of curriculum completion. The College also will consider non-academic qualifications such as leadership skills, diversity in personal background, work experience, motivation, and maturity.

Transfer applicants will be considered for admission directly to the major or the Transfer Transition Program based on the number of transfer credits and GPA.

Admission to the Major

Students admitted to the First-Year Program or Transfer Transition Program (Engineering-Intended or Computer Science-Intended) may apply for major status with their academic advisor at the time they believe they meet the requirements. The program may impose major status as a prerequisite for courses numbered 200 or above.

1. Complete first semester calculus with a C or better grade.
2. Complete GER Oral and Written Communication Part A.
3. Engineering majors must complete Chem 100 with a C or better grade (or satisfactory score on the placement test). Computer Science majors must complete CompSci 251 with a C or better grade.
4. Obtain a minimum grade point as set by the major department. A 3.00 GPA guarantees admission to any CEAS major.
5. Courses required by the major may be repeated only once. No more than two courses may be repeated.

First-Year students have a maximum of three semesters to complete the admission to major requirements. Part-time students may be granted an extension by their academic advisor.

Transfer Transition students have a maximum of two semesters to complete the admission to major requirements. Part-time students may be granted an extension by their academic advisor.

Placement Testing

Most new freshmen are required to take placement exams in English and mathematics. Engineering students also take a placement exam in chemistry, provided they have had previous coursework in chemistry. Students with previous college-level credits in chemistry, English, and math may not be required to take placement tests. Additional prerequisite coursework may be required as a result of these placement tests. Credit for prerequisite academic work may not count toward the degree program. Entering students are urged to take their placement exams when scheduled. All placement exams must be completed before beginning coursework in the subject area. Students who place into precalculus math courses may be asked to participate in an online summer bridge program.

Questions on admission to CEAS or choosing a major should be directed to the Office of Student Services, (414) 229-4667.

Computer Science Curriculum

The minimum number of credits required to complete the Bachelor of Science in Computer Science with a major in Computer Science is 120.

Students who need background preparation courses in math, English, and foreign language may need additional credits. Computer Science students may apply for major status with their academic advisor at any time they believe they meet the requirements. Admission to major is a graduation requirement. Programs may impose major status as a prerequisite for courses numbered 200 or above.

Code	Title	Credits
Major Requirements		
COMPSCI 150	Survey of Computer Science (recommended)	3
COMPSCI 250	Introductory Computer Programming	3
COMPSCI 251	Intermediate Computer Programming	3
COMPSCI 315	Introduction to Computer Organization and Assembly Language Programming	3
COMPSCI 317	Discrete Information Structures	3
COMPSCI 337	System Programming	3
COMPSCI 351	Data Structures and Algorithms	3
COMPSCI 361	Introduction to Software Engineering	3
COMPSCI 395	Social, Professional, and Ethical Issues	3
COMPSCI 417	Introduction to the Theory of Computation	3
COMPSCI 431	Programming Languages Concepts	3
COMPSCI 458	Computer Architecture	3
COMPSCI 520	Computer Networks	3
COMPSCI 535	Algorithm Design and Analysis	3
COMPSCI 537	Introduction to Operating Systems	3
COMPSCI 595	Capstone Project	4
EAS 200	Professional Seminar	1
ELECENG 354	Digital Logic	3
Mathematics Requirement ¹		
Select one of the following:		4-5
MATH 211	Survey in Calculus and Analytic Geometry	
MATH 213	Calculus with Life Sciences Applications	
MATH 221	Honors Calculus I	
MATH 231	Calculus and Analytic Geometry I	
Natural Science Requirement		
Complete 12 credits including at least 1 laboratory credit.		12
Must include one of the following sequences:		
BIO SCI 150 & BIO SCI 152	Foundations of Biological Sciences I and Foundations of Biological Sciences II	
BIO SCI 202 & BIO SCI 203	Anatomy and Physiology I and Anatomy and Physiology II	
CHEM 102 & CHEM 104	General Chemistry and General Chemistry and Qualitative Analysis	
PHYSICS 120 & PHYSICS 122	General Physics I (Non-Calculus Treatment) and General Physics II (Non-Calculus Treatment)	
PHYSICS 209 & PHYSICS 210	Physics I (Calculus Treatment) and Physics II (Calculus Treatment)	

Remaining credits to be chosen from the Natural Science GER list, except that CompSci 150, Math and MathStat courses may not be used as part of the Natural Science Requirement.

GER Distribution Requirement

Arts		3
Humanities		3
Social Science		3
COMMUN 105	Business and Professional Communication	3
ENGLISH 310	Writing, Speaking, and Technoscience in the 21st Century	3

Cultural Diversity - Arts, Humanities, or Social Science course must also satisfy UWM Cultural Diversity Requirement

English Composition Requirement¹

Satisfied by one of the following:	0-6
Earning a satisfactory score on the English placement test; or	
Earning a grade of C or higher in ENGLISH 102; or	
Transferring a grade of C or higher in a course equivalent to ENGLISH 102 or higher expository writing course; or	

Foreign Language Requirement

The foreign language requirement can be completed with one of these options:	0-8
Two years of a single foreign language in high school;	
Two semesters of a single foreign language in college; or	

¹ **Placement Examinations.** Once admitted to UWM, most computer science students are required to take placement examinations in mathematics and English. Students with previous college-level credits in these areas may not be required to take placement exams. The placement exams are administered by the UWM Testing Center, Mellencamp Hall, Room B28, (414) 229-4689. The results of these tests help students determine the appropriate course in which to register. Background prerequisite courses may be required in addition to the courses listed above.

Technical Electives - Select 15 credits from the following three lists:

All non-required CompSci courses numbered 400-699 are either Computer Science or Applied Technology Electives. The Applied Technology Electives are numbered 480-489. All other non-required CompSci courses in the 400-600 range are Computer Science Electives. A minimum of 9 credits must come from the Computer Science Electives.

Code	Title	Credits
Computer Science Electives		
Select 9-15 credits from the following:		9-15
COMPSCI 422	Introduction to Artificial Intelligence	
COMPSCI 423	Introduction to Natural Language Processing	
COMPSCI 425	Introduction to Data Mining	
COMPSCI 444	Introduction to Text Retrieval and Its Applications in Biomedicine	
COMPSCI 459	Fundamentals of Computer Graphics	
COMPSCI 444	Introduction to Text Retrieval and Its Applications in Biomedicine	
COMPSCI 459	Fundamentals of Computer Graphics	
COMPSCI 469	Introduction to Computer Security	

COMPSCI 511	Symbolic Logic
COMPSCI 530	Computer Networks Laboratory
COMPSCI 536	Software Engineering
COMPSCI 552	Advanced Object-Oriented Programming
COMPSCI 557	Introduction to Database Systems
COMPSCI 581	Web Languages and Standards
COMPSCI 599	Senior Thesis
COMPSCI 654	Introduction to Compilers
COMPSCI 655	Compiler Implementation Laboratory
COMPSCI 657	Topics in Computer Science:
COMPSCI 699	Independent Study
ELECENG 367	Introduction to Microprocessors
ELECENG 451	Introduction to VLSI Design
ELECENG 457	Digital Logic Laboratory

Applied Technology Electives

Select 0-6 credits from the following: 0-6

COMPSCI 481	Server-side Internet Programming
COMPSCI 482	Rich Internet Applications
COMPSCI 658	Topics in Applied Computing:

Supplemental Electives

Select 0-6 credits from the following: 0-6

BUS ADM 490	Entrepreneur Internship
EAS 1	Engineering Co-op Work Period
EAS 497	Study Abroad:
ENGLISH 206	Technical Writing

Applied Mathematics Electives

Code	Title	Credits
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Select 9 credits from the following: 9

IND ENG 367	Introductory Statistics for Physical Sciences and Engineering Students	
MATH 205	Introductory Finite Mathematics	
MATH 232	Calculus and Analytic Geometry II	
MATH 233	Calculus and Analytic Geometry III	
MATH 234	Linear Algebra and Differential Equations ^{2,3}	
ELECENG 234	Analytical Methods in Engineering ^{2,3}	
MATH 240	Matrices and Applications ²	
MATH 320	Introduction to Differential Equations ³	
MATH 305	Introduction to Mathematical and Computational Modeling	
MATH 313	Linear Programming and Optimization	
MATH 315	Mathematical Programming and Optimization	
MATH 341	Seminar: Introduction to the Language and Practice of Mathematics	
MATH 405	Mathematical Models and Applications	
MATH 431	Modern Algebra with Applications	
MATH 451	Axiomatic Geometry	
MTHSTAT 361	Introduction to Mathematical Statistics I	

MTHSTAT 469	Biostatistics
MTHSTAT 563	Regression Analysis

² May include only one of MATH 240, MATH 234, ELECENG 234.³ May include only one of MATH 320, MATH 234, ELECENG 234.

Minimum Requirements

Students must maintain an average GPA of at least 2.00 on all work attempted at the University and in all courses offered by the College. Students majoring in biomedical engineering, computer engineering, computer science, industrial engineering, and materials engineering must maintain an average GPA of at least 2.00 in all 300-level and above courses in the student's major department. Students majoring in civil engineering, electrical engineering, and mechanical engineering must maintain an average GPA of at least 2.50 in all 300-level and above courses in the major department. Transferable courses will be included as appropriate. Advancement to major status is required for graduation.

In order to provide maximum flexibility while preserving the institutional identity of a UWM degree, the College requires residence:

1. during the last 30 credits, or
2. during 45 of the last 60 credits, or
3. during any 90 credits of a student's undergraduate career.

At least 15 credits of advanced work in the major must be completed in residence at UWM.

A student who does not maintain continuous registration during the academic year and is re-admitted to the College must meet the program and graduation requirements in effect at the time of re-entry.

Degree and major requirements must be completed within 10 years of initial enrollment at UW-Milwaukee. Should students not complete the major within the 10-year time frame, the students will switch to the most current degree and major requirements. A new 10-year time frame would then begin.

Dual Majors

Students wishing to major in more than one field can do so in two ways:

1. Complete the requirements for more than one major before receiving a degree from the College. In this case, the degree will list both majors.
2. Be admitted to the College as a second degree candidate (after earning a bachelor's degree in any field), providing University and College entrance requirements are met. Such a student must meet all undergraduate degree requirements in the College and present a minimum of 30 credits beyond the previous bachelor's degree.

Concurrent Registration at Other Institutions

CEAS students wishing to establish concurrent enrollment at another institution must obtain prior permission from their academic advisor.

Student Academic Appeals

Students may appeal an academic action to the Office of Student Services. An appeal is a request for an exception to an established policy or rule. The content of each appeal is carefully reviewed in order to reach a decision. Appeals should be submitted in writing to the

Office of Student Services. The appeals committee considers individual cases concerning the degree requirements and other academic rules and regulations established by the College of Engineering and Applied Science faculty.

The College of Engineering and Applied Science has established written procedures for undergraduate student academic grievances. Copies of the grievance procedure are available in the Office of Student Services. As a first step, students must discuss the grievance with the faculty member or administrator as soon as possible to attempt to resolve the issue, but not later than 30 days after the action that prompted the grievance/appeal.

Computer Science and Engineering Programs

Detailed descriptions of the CEAS undergraduate programs are provided in this catalog. All courses are not offered every semester. A few technical elective courses may be offered only once every three to four semesters. In addition, since computer science and engineering curricula are continually evolving to keep current, students are encouraged to consult with their advisors to plan each semester's list of classes. Part-time students should always maintain a plan that looks ahead two to three semesters to avoid scheduling difficulties.

The curricula outlined in the pages are applicable to new students entering CEAS in fall 2016 or later. Students who enrolled in computer science or engineering programs prior to that date should consult with the appropriate previous editions of this catalog for information about their program requirements. As a general rule, when program changes occur, continuing students have the choice of continuing in their existing program or following the new requirements. Occasionally, a program change will be required of all students regardless of their date of matriculation, so long as it does not increase the total credits needed for graduation.

These program descriptions represent the minimum requirements for graduation from UWM in computer science or engineering. In all cases, it is important that students consult with their advisor before making course selections to avoid errors in programming.

Academic Advising

The Office of Student Services in the College of Engineering and Applied Science, located in Room E386 of the Engineering and Mathematical Sciences Building, offers undergraduate students academic advising from professional advisors who are familiar with the curriculum, College requirements, and the special needs of engineering and computer science students. These advisors provide services such as freshman orientation, course selection, program planning, and credit transfer evaluation. Students are assigned to a permanent professional advisor as soon as they are accepted into the College, and are urged to confer with their advisor at least once each semester. Students also are assigned to a faculty advisor who provides technical expertise specific to the student's area of study.

We understand that it can be a delicate balance managing school, work, family, and active social lives. The College of Engineering and Applied Science advisors are here to help you achieve that balance.

You will be assigned a professional academic advisor upon being admitted to the College of Engineering & Applied Science. Your advisor

will work with you throughout your undergraduate experience, providing guidance on:

- course registration,
- graduation planning,
- career preparation,
- and serving as a liaison to the many other resources available on our campus.

Advisors are also a great source of information on student organizations, tutoring and scholarship opportunities.

In addition to professional academic advisors, you will also have access to faculty advisors. These advisors can provide insights into the technical aspects of the engineering and computer science curricula while mentoring you as you define your professional goals.

Program Educational Objectives

The educational objectives of the undergraduate Computer Science Program are:

1. Alumni of the program will have successful careers built on their understanding of formal and applied methods of solving problems using computer theory, hardware, and software.
2. In their professional lives, alumni of the program will demonstrate problem-solving and design skills, including the ability to formulate problems and their solutions, think creatively, communicate effectively, and work collaboratively.
3. Alumni of the program will exercise professional responsibility and be able to adapt to an ever-changing professional environment.

Honors in the College of Engineering and Applied Science

Dean's Honor List

GPA of 3.500 or above, earned on a full-time student's GPA on 12 or more graded credits in a given semester.

Honors Degree and Honors Degree with Thesis

Granted to graduating seniors who complete Honors College requirements, as listed in the Honors College (<http://catalog.uwm.edu/opportunities-resources/honors-college>) section of this site.

Commencement Honors

Students with a cumulative GPA of 3.500 or above, based on a minimum of 40 graded UWM credits earned prior to the final semester, will receive all-university commencement honors and be awarded the traditional gold cord at the December or May Honors Convocation. In schools and colleges in which fewer than 15% of the traditional students have a 3.500 GPA, all-university honors will be awarded to approximately the top 15% of graduating students. A criterion GPA (not lower than 3.200) for this 15% will be calculated based on statistics from the previous comparable semester. Please note that for honors calculation, the GPA is **not** rounded and is truncated at the third decimal (e.g., 3.499).

Final Honors

Earned on a minimum of 60 graded UWM credits: Cum Laude - 3.500 or above; Magna Cum Laude - 3.650 or above; Summa Cum Laude - 3.800 or above.

Joint Programs with Other Campuses

Pre-engineering

Qualified students may enroll in coordinated pre-engineering programs at UW-Green Bay, UW-Parkside, and UW-Waukesha for two years of pre-engineering coursework. These coordinated programs ensure equivalent coursework, appropriate advising, and early access to the Cooperative Education Program at UWM.

Dual Degree Programs

Qualified students may enroll in coordinated dual degree programs at Alverno College, Carroll University, UW-Eau Claire, UW-Green Bay, UW-La Crosse, UW-Oshkosh, UW-Stevens Point, UW-Whitewater and Wisconsin Lutheran College. Students in these programs will earn a bachelor's degree at both universities in five years. Students transfer to UWM after three years at the partner university. For more information, contact the Office of Student Services at (414) 229-4667.

Joint Programs with Wisconsin Technical Colleges

Gateway Technical College

An agreement with GTC allows those students having associate degrees in the Electrical Engineering - Technology the opportunity to be given credit for courses required in the UWM bachelor of science in engineering program. For more information, contact the Office of Student Services at (414) 229-4667.

Milwaukee Area Technical College

An agreement with MATC allows joint admission and enrollment at MATC and CEAS. Qualified students may take English, mathematics, chemistry, and general education courses at MATC. The program ensures equivalent coursework and appropriate advising. Students complete a bachelor of science degree in engineering or computer science at UWM.

Waukesha County Technical College

An agreement with WCTC allows those students having associate degrees in the Industrial Occupations Division at WCTC the opportunity to be given credit for courses required in the UWM bachelor of science in engineering or bachelor of science in computer science program. For more information, contact the Office of Student Services at (414) 229-4667.