

COMPUTER ENGINEERING, BS

The Computer Engineering major is offered through the Electrical Engineering and Computer Science departments at UWM. Computer engineering pertains to the design, implementation and maintenance of hardware and software components of computers and computer-controlled equipment.

Our program provides students with a broad and strong technical background in the field. It also helps students develop a solid grounding in computing, mathematics and engineering. Students will learn to apply these theoretical principles to design hardware, software, networks, and computerized equipment for diverse application domains.

Accreditation

The Computer Engineering program is accredited by the Engineering Accreditation Commission of ABET: <https://www.abet.org> (<https://nam02.safelinks.protection.outlook.com/?url=https%3A%2F%2Fwww.abet.org%2F&data=02%7C01%7Cebilicki%40uwm.edu%7Cbc1f9a3ce174b5fcecc08d863abd8be%7C0bca7ac3fb64efd89eb6de97603cf21%7C0%7C0%7C637368937031393544&data=oMZNZVPTMndkhnNS&data=02%7C01%7Cebilicki%40uwm.edu%7Cbc1f9a3ce174b5fcecc08d863abd8be%7C0bca7ac3fb64efd89eb6de97603cf21%7C0%7C0%7C637368937031393544&reserved=0>).

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 intended status (Engineering-Intended or Computer Science-Intended). 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 to intended status (Engineering-Intended or Computer Science-Intended).

Admission to the Major

Students admitted to 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.

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

Computer Engineering Curriculum

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

Code	Title	Credits
Engineering Core - 10 Credits		
COMPSCI 250	Introductory Computer Programming	3
EAS 200	Professional Seminar	1
ELECENG 301	Electrical Circuits I	3
IND ENG 367	Introductory Statistics for Physical Sciences and Engineering Students	3
Major Requirements - 51 Credits		
COMPSCI 251	Intermediate Computer 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 458	Computer Architecture	3
COMPSCI 520	Computer Networks	3
COMPSCI 535	Algorithm Design and Analysis	3
COMPSCI 537	Introduction to Operating Systems	3
ELECENG 305	Electrical Circuits II	4
ELECENG 310	Signals and Systems	3
ELECENG 330	Electronics I	4
ELECENG 354	Digital Logic	3
ELECENG 367	Introduction to Microprocessors	4
ELECENG 457	Digital Logic Laboratory	3
Mathematics Requirement - 16 Credits ¹		
MATH 231	Calculus and Analytic Geometry I	4
MATH 232	Calculus and Analytic Geometry II	4
MATH 233	Calculus and Analytic Geometry III	4
ELECENG 234	Analytical Methods in Engineering	4
Chemistry or Biology Requirement - 4-5 Credits		
Select one of the following:		4-5
CHEM 105	General Chemistry for Engineering	
CHEM 102	General Chemistry	
BIO SCI 150	Foundations of Biological Sciences I	
BIO SCI 202	Anatomy and Physiology I	
Physics Requirement - 8 Credits		

PHYSICS 209 Physics I (Calculus Treatment) 8
& PHYSICS 210 and Physics II (Calculus Treatment)

Technical Electives - 16 Credits 16

Group A Technical Electives - Select 9 to 12 credits from the following list. All COMPSCI and ELECENG courses numbered 300-699 that are not explicitly listed as Engineering Core, Major, Group B or Group C

COMPSCI 315	Introduction to Computer Organization and Assembly Language Programming
COMPSCI 318	Topics in Discrete Mathematics
COMPSCI 411	Machine Learning and Applications
COMPSCI 417	Introduction to the Theory of Computation
COMPSCI 422	Introduction to Artificial Intelligence
COMPSCI 423	Introduction to Natural Language Processing
COMPSCI 425	Introduction to Data Mining
COMPSCI 431	Programming Languages Concepts
COMPSCI 443	Intelligent User Interfaces and Usability Assessment
COMPSCI 459	Fundamentals of Computer Graphics
COMPSCI 469	Introduction to Computer Security
COMPSCI 511	Symbolic Logic
COMPSCI 522	Computer Game Design
COMPSCI 530	Computer Networks Laboratory
COMPSCI 536	Software Engineering
COMPSCI 545	FPGA Embedded CPUs & Firmware Development
COMPSCI 547	User-Centered Interaction Design
COMPSCI 557	Introduction to Database Systems
COMPSCI 654	Introduction to Compilers
COMPSCI 655	Compiler Implementation Laboratory
COMPSCI 657	Topics in Computer Science:
COMPSCI 699	Independent Study
ELECENG 335	Electronics II
ELECENG 361	Electromagnetic Fields
ELECENG 362	Electromechanical Energy Conversion
ELECENG 410	Digital Signal Processing
ELECENG 420	Random Signals and Systems
ELECENG 421	Communication Systems
ELECENG 430	Energy Modeling
ELECENG 436	Introduction to Medical Instrumentation
ELECENG 437	Introduction to Biomedical Imaging
ELECENG 439	Introduction to Biomedical Optics
ELECENG 451	Introduction to VLSI Design
ELECENG 461	Microwave Engineering
ELECENG 462	Antenna Theory
ELECENG 464	Fundamentals of Photonics
ELECENG 465	Broadband Optical Networks
ELECENG 474	Introduction to Control Systems
ELECENG 482	Introduction to Nanoelectronics
ELECENG 490	Topics in Electrical Engineering:
ELECENG 541	Integrated Circuits and Systems
ELECENG 545	FPGA Embedded CPUs & Firmware Development

ELECENG 562	Telecommunication Circuits
ELECENG 568	Applications of Digital Signal Processing
ELECENG 572	Power Electronics
ELECENG 574	Intermediate Control Systems
ELECENG 575	Analysis of Electric Machines and Motor Drives
ELECENG 588	Fundamentals of Nanotechnology
ELECENG 699	Independent Study
IND ENG 475	Simulation Methodology
IND ENG 572	Reliability Engineering

Group B Technical Electives - 4 credits

COMPSCI 595	Capstone Project
or ELECENG 595	Capstone Design Project

Group C Technical Electives - Select 0 to 3 credits from the following list

BIO SCI 150	Foundations of Biological Sciences I ²
BIO SCI 152	Foundations of Biological Sciences II
BUS ADM 292	Introduction to Entrepreneurship and Small Business Formation
BUS ADM 447	Entrepreneurship
COMPSCI 481	Server-side Internet Programming
COMPSCI 482	Rich Internet Applications
COMPSCI 581	Web Languages and Standards
COMPSCI 658	Topics in Applied Computing:
EAS 1	Engineering Co-op Work Period ³
EAS 497	Study Abroad:
ELECENG 471	Electric Power Systems
ELECENG 472	Introduction to Wind Energy
ELECENG 481	Electronic Materials
ENGLISH 206	Technical Writing
IND ENG 360	Engineering Economic Analysis
MATLENG 481	Electronic Materials
MECHENG 301	Basic Engineering Thermodynamics
MECHENG 321	Basic Heat Transfer
MECHENG 542	Introduction to Technology Entrepreneurship
MECHENG 543	Introduction to Technology Management and Innovation

GER Distribution Requirement - 15 Credits

Arts	3	
Humanities	3	
Social Science	6	
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 Requirement

Select one of the following:	0-6
Earning a satisfactory score on the English placement test, or other appropriate test as determined by the English Department; 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

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

Demonstrate ability by examination

Total Credits 120-121

- ¹ MATH 221, MATH 222, and 2 credits of Free Electives may substitute for MATH 231, MATH 232 and MATH 233
- ² Cannot be counted as a technical elective if taken to fulfill Chemistry or Biology Requirement above
- ³ Students who earn 3 or more credits of EAS 1 may use 3 of those credits as technical electives

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.

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 College Degree and Honors College Degree with Distinction

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. 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.