

# 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=oMZNZVPDTMndkhnNS&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 |
|--|--|---------|
| <b>Engineering Core - 10 Credits</b>                     |  |         |
| 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       |
| <b>Major Requirements - 51 Credits</b>                   |  |         |
| 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       |
| <b>Mathematics Requirement - 16 Credits <sup>1</sup></b> |  |         |
| 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       |
| <b>Chemistry or Biology Requirement - 4-5 Credits</b>    |  |         |
| 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   |         |
| <b>Physics Requirement - 8 Credits</b>                   |  |         |

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 <sup>2</sup>             |
| 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 <sup>3</sup>                    |
| 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

- <sup>1</sup> MATH 221, MATH 222, and 2 credits of Free Electives may substitute for MATH 231, MATH 232 and MATH 233
- <sup>2</sup> Cannot be counted as a technical elective if taken to fulfill Chemistry or Biology Requirement above
- <sup>3</sup> 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.