College of Engineering

Dean

- Harriet Nembhard

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Undergraduate degree: B.S.E.
Undergraduate certificates: artificial intelligence, modeling and simulation in engineering; naval science and technology; technological entrepreneurship
Graduate degrees: M.S.; Ph.D.
Graduate certificates: artificial intelligence, modeling and simulation in engineering; sustainable water development
Website: https://engineering.uiowa.edu/

Engineers play an important role in modern society. They design and develop new and improved materials, products, and processes ranging from nanoparticles to antibiotics to major bridges and dams. Engineers are in demand across a broad spectrum of industry, spanning traditional fields such as mechanical and electrical engineering to the emerging fields of artificial intelligence and medicine. Engineers not only satisfy society's demand for improved performance, reliability, and safety of products, they also supply solutions for unforeseen societal consequences that may arise as the result of new technologies.

The College of Engineering has six academic departments: the Roy J. Carver Department of Biomedical Engineering, and the Departments of Chemical and Biochemical Engineering, Civil and Environmental Engineering, Electrical and Computer Engineering, Industrial and Systems Engineering, and Mechanical Engineering.

Moreover, research and educational activities of the college are supported by four research centers and institutes: the Center for Bioinformatics and Computational Biology, the Iowa Institute for Biomedical Imaging, IIHR—Hydroscience & Engineering, and the Iowa Technology Institute.

Programs

Undergraduate Programs of Study

The College of Engineering offers the Bachelor of Science in Engineering (B.S.E.) with majors in biomedical, chemical, civil, computer science and engineering, electrical, environmental, industrial, and mechanical engineering. For information about each B.S.E. major, see the Catalog's College of Engineering department sections.

The college also offers combined undergraduate degree programs with the College of Liberal Arts and Sciences and the Tippie College of Business; a dual degree with the University of Northern Iowa; a combined B.S.E./master's degree program in each engineering discipline; and combined B.S.E./master's degrees with the Department of Computer Science, the Department of Occupational and Environmental Health, and the School of Planning and Public Affairs (also see the graduate Certificate in Transportation Planning in the Graduate College). For additional information, see "Combined and Dual Degrees" in the Bachelor of Science in Engineering, B.S.E. section of the Catalog.

In addition, the College of Engineering offers the undergraduate Certificate in Artificial Intelligence, Modeling and Simulation in Engineering, a Certificate in Naval Science and Technology, and partners with the Tippie College of Business to offer a Certificate in Technological Entrepreneurship for undergraduate engineering students.

Graduate Programs of Study

The College of Engineering offers graduate degree programs, the Master of Science (M.S.) and Doctor of Philosophy (Ph.D.), in biomedical engineering, chemical and biochemical engineering, civil and environmental engineering, electrical and computer engineering, industrial engineering, and mechanical engineering. See the College of Engineering Graduate Studies website for an overview, and the departmental sections in the Catalog for information about specific areas of research and study, admission and degree requirements, and financial support for the graduate programs. The College of Engineering also offers the graduate Certificate in Artificial Intelligence, Modeling and Simulation in Engineering, and a graduate Certificate in Sustainable Water Development.

High School Program of Study

FIRST Tech Challenge

For Inspiration and Recognition of Science and Technology (FIRST) gives students the opportunity for real-world application of science, technology, engineering, and math (STEM) concepts. Students participate in an atmosphere that encourages team building, entrepreneurship, and sportsmanship. FIRST Tech Challenge (FTC) allows teams of students to be responsible for designing, building, and programming robots to compete in an alliance format against other teams. Teams are required to develop strategy and build robots based on sound engineering principles. Students learn about working in a team environment, effective communication skills, the ability to fail and succeed at the same time, and competing fairly while being supportive of their competition.

Facilities and Resources

College of Engineering Facilities

Seamans Center for the Engineering Arts and Sciences

The Seamans Center for the Engineering Arts and Sciences is home to the College of Engineering. In addition to faculty offices, classrooms, conference rooms, instructional laboratories, and faculty offices, the Seamans Center houses the Lichtenberger Engineering Library, the Hanson Center for Technical Communication, a machine shop, electronic shop, student work spaces, computational facilities, and research laboratories. A number of classrooms and open spaces located throughout the building were designed to readily accommodate collaborative work.

Engineering Student Services

The professional staff of Engineering Student Services administer student services for the College of Engineering, including advising, tutoring, student records, and global engineering. It also is the administrative home of Engineering Career Services and the Hanson Center for Technical Communication.

Engineering Career Services

Engineering Career Services develops and promotes experiential education and professional opportunities for students in the College of Engineering. Professional staff coordinate the college's co-op and internship program, engage in employer outreach, and provide opportunities for students to network with employers, including engineering career fairs and other programming related to career development.

Engineering Career Services offers individual advising and class presentations on résumé and cover letter preparation, job and internship search strategies, interviewing skills, job offer evaluation, and much more. Engineering Career Services partners with the Pomerantz Career Center to facilitate on-campus interviewing, postgraduation outcome collection, and the University's online recruiting system, Handshake.

Hanson Center for Communication

The Hanson Center for Communication is an endowed program that works closely with engineering faculty to create, manage, and grade writing assignments across the curriculum. In addition, the Hanson Center for Communication is home to an innovative writing center that conducts hundreds of one-on-one and team tutoring sessions each year. The center helps review lab reports, topical papers, and technical essays each semester.

Peer tutors are undergraduate students who have shown exceptional promise as communicators and provide individualized feedback throughout the writing process. In addressing global concerns (organization, clarity, and relevant analysis), they help their fellow students transform rough drafts into persuasive, logical documents.

Global Engineering

Many of today’s top employers are seeking engineering graduates with global experiences and competencies who can effectively interact with colleagues and customers around the world. Successful engineers are able to communicate across cultures, work on diverse teams, and productively deal with issues and conflicts arising from difference.

University of Iowa engineering students have a variety of opportunities to study, pursue internships, or conduct research abroad. Students can enroll in credit-bearing courses in English to fulfill engineering or general education requirements or earn credits toward a minor in another discipline or world language. In addition to completing coursework abroad, engineering students can pursue experiential opportunities abroad, including global internships, conducting independent research in other countries, and volunteering. For more information, see Global Engineering on the College of Engineering website. The College of Engineering and International Programs support these endeavors by offering students a variety of scholarships and funding.

Engineering Computer Services

Engineering Computer Services (ECS) provides spaces and technology administration for curricular, administrative, and research computing at the College of Engineering. The college has three drop-in computer labs with 225 high-end Linux and Windows computer workstations with graphics processing unit (GPU) support, a 24-seat computer classroom, a 45-seat machine learning and virtual reality-capable computer classroom, and a 400-seat virtual computer lab with GPU support that students can access from the internet. Numerous public domain and commercial engineering applications support the full range of engineering classes. Software is regularly upgraded, and hardware is refreshed at least every four years. The college's computer labs are open 24 hours a day, every day of the year.

Engineering Electronics Shop

The Engineering Electronics Shop (EES) is a full-service electronics facility that supports sales and service for the College of Engineering and the University. EES provides design, construction, repair, calibration, and preventive maintenance services for teaching and research laboratories. The shop maintains more than 10,000 parts in stock, including electronic components, computer and office supplies, and lockers for rent. The shop has laser cutting/etching equipment, 3D printers, and a poster-plotting service.

Engineering Machine Shop

The Engineering Machine Shop (EMS) is a full-service, light manufacturing facility that supports curricular, research, and operational needs of the College of Engineering and the University. EMS provides professional design and fabrication services and gives students, staff, and faculty controlled access to a student shop that contains a variety of manufacturing equipment. The shop has a high resolution 3D scanner, commercial 3D printers, a waterjet, a full wood shop, welding, and multi-axis CNC machines.

Lichtenberger Engineering Library

The Lichtenberger Engineering Library is a branch of the University of Iowa Main Library and is a center of engineering college activity. Its collection includes books (including required course textbooks), tools, equipment, and electronic resources to assist at any stage of research on projects both big and small. Staff are trained to help locate information and provide training on a wide variety of skills, including patent searching, data management, tool usage, and more.

The Engineering Library, located next to the Student Commons in the Seamans Center, provides access to computer workstations, quiet study in the lower level, and group study space where students may reserve a private room for their work. The Engineering Library also houses the Creative Space, a space for students to imagine, tinker, design, and create with virtual reality, 3D scanners, and more.

NEXUS

The NEXUS Program is an art and engineering program. NEXUS promotes collaboration efforts between the College of Engineering and the art community by getting people and ideas together. The goal is to involve students in science, technology, engineering, arts, and mathematics (STEAM) projects throughout the University and the surrounding community. The program helps participants to think outside the box.

College of Engineering Research Centers

Center for Bioinformatics and Computational Biology

The Center for Bioinformatics and Computational Biology (CBCB) is a multidisciplinary research center dedicated to applying high performance networking and computing to basic life science and applied biomedical research. With faculty and students representing more than 20 traditional disciplines, the CBCB has contributed to the understanding of inherited human diseases, including blinding eye disease, cancer, deafness, diabetes, autism, schizophrenia, hypertension, obesity, and heart disease. For almost 20 years, the CBCB has been at the cutting edge of high throughput molecular discovery and interpretation in transcriptomics, genomics, and proteomics. At the confluence of these efforts lies the current wavefront of personalized genomic medicine, in which the CBCB plays a central role in partnership with labs, centers, and institutes across the University's Carver College of Medicine and basic science programs across campus. The CBCB also has been a center for industry start-ups and partnerships with numerous commercial enterprises. The center is jointly sponsored by the College of Engineering and the Carver College of Medicine.

Iowa Institute for Biomedical Imaging

The Iowa Institute for Biomedical Imaging (IIBI) conducts research in the following areas: medical imaging (CT, MR, OCT, PET, SPECT, ultrasound, multimodality imaging), medical image analysis and computer-aided diagnosis; cardiovascular image analysis (angiography-intravascular ultrasound data fusion, MR image analysis of congenital heart disease, coronary CT image analysis, early detection of cardiovascular disease); pulmonary image analysis (CT and MR image analysis of the lung); cell image analysis (cell tracking, shape analysis); virtual surgery planning (augmented reality for surgical planning), cancer-related assessment of tumor progression/regression, staging, general machine learning; and disease/treatment outcome prediction. The institute is sponsored by the College of Engineering and the Carver College of Medicine.

IIHR—Hydroscience & Engineering

IIHR—Hydroscience & Engineering is a world-renowned center with more than 100 years of education, research, and public service focusing on hydraulic engineering and fluid mechanics. Based in the C. Maxwell Stanley Hydraulics Laboratory, a five-story red brick building on the banks of the Iowa River, IIHR is a unit of the College of Engineering. IIHR students, faculty members, research engineers and scientists, and staff work together to understand and manage one of the world’s greatest resources—water. Students from around the world benefit from IIHR’s comprehensive multidisciplinary approach, which includes basic fluid mechanics, laboratory experimentation, and computational approaches.

IIHR research activities include fluid dynamics (turbulent flows, vortex dynamics, ship hydrodynamics, biological fluid flow, atmospheric boundary layer, experimental and computational fluid dynamics); environmental hydraulics (river mechanics, hydraulic structures, fish passage, sediment management, heat disposal in water bodies and power productions, bioremediation of groundwater, computational hydraulics, water-quality monitoring); water and air resources (air pollution, hydroclimatology, hydrogeology, hydrology, hydrometeorology, remote sensing, water resources and basin-scale processes); environmental engineering and science (PCBs in the air and water, innovative ways of removing contaminants from the soil and water, ultra-fine particles of pollutants in the atmosphere, bioremediation strategies for persistent groundwater contaminants); and water sustainability (development of sound strategies and technological solutions to meet the challenges facing society's growing need for water resources). In 2009, the Iowa Flood Center was founded at IIHR as the only academic center devoted solely to flood-related research and education.

The University of Iowa’s Water Sustainability Initiative (WSI) brought new interdisciplinary expertise to the institute in 2013 when WSI faculty members (based in the Colleges of Liberal Arts and Sciences, Engineering, and Public Health) affiliated with IIHR. The Iowa Geological Survey joined IIHR in 2014, bringing new expertise in Iowa's subsurface resources, groundwater modeling, innovative geophysical skills, and more.

Students gain hands-on experience through close cooperation with faculty and staff on research projects funded by industry, government, and other organizations.

Iowa Technology Institute

The Iowa Technology Institute (ITI) conducts basic and applied research. The mission is to cultivate collaboration across disciplines, invent advanced technologies, and conduct trailblazing research in design, simulation, and experimentation that enables a safer and more productive future. ITI provides a unique environment for research and development for faculty, graduate and undergraduate students, research fellows, and professional scientists. ITI spans more than 20 laboratories and centers, led by the Operator Performance Laboratory, the Virtual Soldier Research program, and the Atmospheric and Environmental Research Lab.

Research at ITI focuses on advanced manufacturing and materials, human modeling and simulation, aerospace technology, biotechnology, environment and energy, and systems and sensors. Scientists conduct experiments in flight testing, human performance, robotics, biomedical and biochemical research, machine learning, smart sensors, remote sensing, renewable energy, and modeling of environmental change.

ITI has a satellite office in Orlando, Florida, and has major contracts with the U.S. military and industry partners.

Courses

The engineering course requirements for engineering majors are outlined in the respective Catalog sections. Each undergraduate program builds upon a core program; see the Bachelor of Science in Engineering in the Catalog. Not all engineering core courses listed below are required for each engineering major. Core program courses are intended for College of Engineering students. Undergraduate students in other disciplines who wish to register for core engineering courses should contact Engineering Student Services.

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Engineering Courses

ENGR:0000 Engineering Internships and Co-ops 0 s.h.
For engineering students completing a semester-long internship experience while working 35-40 hours a week at a professional company.

ENGR:0001 Engineering Co-op 0 s.h.
Multiple-semester cooperative education experience for students working 35-40 hours a week at a professional company.

ENGR:0002 Engineering Half-Time Internship 0 s.h.
For engineering majors participating in the Cooperative Education and Internship Program and averaging 15-20 hours per week on assignment.

ENGR:0004 Engineering Academic Internship arr.
Academic credit for engineering majors participating in the Cooperative Education and Internship Program. Requirements: for international students—F-1 or J-1 visa, engineering undergraduate standing, full-time internship offer letter in hand (at least 40 hours/week and one semester in length), internship approved by International Student and Scholar Services for F-1 Curricular Practical Training (CPT) or J-1 Academic Training (AT), concurrent registration in approved 3 s.h. distance education or evening course, and preapproval of internship by Engineering Career Services; non-international students may be eligible on case-by-case basis.

ENGR:0006 Engineering Global Internship/Co-op 0 s.h.
For engineering majors participating in the Cooperative Education and Internship Program working on a global assignment.

ENGR:1000 Engineering Success for First-Year Students 1 s.h.
Introduction to engineering student life; electronic resources; keys to and skills for success; coping with adversity; selecting a major; advising; curriculum choices and career objectives; ethics; communication; internships and co-ops; job search skills.

ENGR:1029 First-Year Seminar arr.
Introduction to engineering fields of study; work closely with a faculty member or senior administrator; participation that eases the transition to college-level learning; cutting-edge research taking place in the College of Engineering.

ENGR:1100 Introduction to Engineering Problem Solving 3 s.h.
Development and demonstration of specific problem solving skills; directed project or case study involving actual engineering problems and their solutions.

ENGR:1300 Introduction to Engineering Computing 3 s.h.
Engineering problem solving using computers; introduction to digital computations, problem formulation using a procedural high-level language; structured, top-down program design methodology; debugging and testing; introduction to use of software libraries; examples from numerical analysis and contemporary applications in engineering. Corequisites: MATH:1550.

ENGR:1550 FIRST Tech Challenge - Introduction to Engineering Problem Solving 3 s.h.
Introduction to engineering problem solving and design; projects introduce students to common elements of engineering problem solving and design (e.g., application of organizing principles to describe engineered systems, economic analysis upon which to base decisions, technical presentation and analysis of data), and provides an opportunity for students to apply common elements of problem solving in the solution of engineering problems in context of a structured problem solving and design process. Taught in high schools by state certified teachers.

ENGR:2110 Statics 2-3 s.h.
Vector algebra, forces, couples, moments, resultants of force couple systems; friction, equilibrium analysis of particles and finite bodies, centroids; applications. Prerequisites: MATH:1550. Corequisites: MATH:1560 and PHYS:1611.

ENGR:2120 Electrical Circuits 3 s.h.
Kirchhoff's laws and network theorems; analysis of DC circuits; first order transient response; sinusoidal steady-state analysis; elementary principles of circuit design; SPICE analysis of DC, AC, and transient circuits. Corequisites: MATH:2560.

ENGR:2130 Thermodynamics 3 s.h.
Basic elements of classical thermodynamics including first and second laws, properties of pure materials, ideal gas law, reversibility and irreversibility, and Carnot cycle; control volume analysis of closed simple systems and open systems at steady state; engineering applications, including cycles. Prerequisites: PHYS:1611 and CHEM:1110. Corequisites: MATH:1560.

ENGR:2510 Fluid Mechanics 4 s.h.
Fluid properties; hydrostatics; transfer of mass, momentum, and energy in control-volume and differential forms; dimensional analysis and similitude; laminar and turbulent flow in conduits; flow past bluff bodies and airfoils; engineering applications; experimental laboratories, computer simulation projects. Prerequisites: MATH:2560 and ENGR:2710. Corequisites: ENGR:2130.

ENGR:2710 Dynamics 3 s.h.
Vector calculus, Newton's laws, 3D motion of particles and multiparticle systems, 2D motion of rigid bodies applications. Prerequisites: ENGR:2110 and MATH:1550.

ENGR:2720 Materials Science 3 s.h.
Concepts and examples of selection and applications of materials used by engineers; mechanical, electrical, and thermal properties that govern a material's suitability for particular applications; lectures supplemented by laboratory experiments. Prerequisites: CHEM:1110. Corequisites: MATH:1550.

ENGR:2730 Computers in Engineering 2-3 s.h.
Advanced programming; good software engineering techniques including pseudocode and documentation dynamic data structures, recursive programming, procedural and object-oriented computing, inheritance, and standard template library; C++. Prerequisites: ENGR:1300.

ENGR:2750 Mechanics of Deformable Bodies 3 s.h.
Elementary theory of deformable bodies, stress, strain; axial, transverse, bending, torsion, combined and buckling loads; deflection of beam. Prerequisites: ENGR:2110. Corequisites: MATH:2560.

ENGR:2995 Introduction to Artificial Intelligence and Machine Learning in Engineering 3 s.h.
Introduction to artificial intelligence (AI), machine learning, data science, and data driven problem solving across all engineering disciplines; topics include supervised and unsupervised learning, clustering, heuristics, feature selection, ethics of AI—fairness and privacy issues, and performance evaluation; first in a series. Prerequisites: ENGR:1300. Corequisites: MATH:2550. Requirements: practical knowledge of programming, rudimentary understanding of probability concepts, and sophomore standing.

ENGR:4000 Engineering Honors Seminar 1 s.h.
Completion of an approved project under the supervision of a faculty member. Requirements: engineering honors and junior or higher standing.

ENGR:4001 Leadership Seminar: Mediocrity is Not an Option 1 s.h.
Skills needed to gain competitive edge in professional world with understanding that mediocrity is not an option; importance of developing a career plan, power of networking, significance of soft skills, value of mentoring; participation in series of discussions and activities; deeper insight of strengths and weaknesses, how to enhance skills that employers desire, and become effective leaders in workplace; presentation by retired chief operating officer of a leading aerospace company.

ENGR:4003 Women in Science and Engineering Leadership Seminar 1 s.h.
WiSE peer mentors develop practical mentoring and leadership skills while participating in a one-on-one relationship with a first-year UI student in a STEM major; peer mentors meet monthly with mentees, submit meeting reflection/evaluations, and attend three educational or social events hosted by WiSE or another University entity during the semester.

ENGR:4005 Developing Cultural Intelligence for STEM Leadership 1 s.h.
How cultural values impact technological innovation; knowledge and strategies to develop skills for leadership in the global marketplace; activities include the Cultural Intelligence (CQ) assessment and mapping of cultural values and case studies for innovation; students use CQ dimensions to develop a plan to deepen CQ skills; exploration of culturally intelligent collaboration and problem solving in science, technology, engineering, and mathematics (STEM) fields; how to represent these skills in professional settings. Requirements: upper-level undergraduate or graduate standing.

ENGR:4010 Engineering Grand Challenges Program Fellow 0 s.h.
The Engineering Grand Challenges Program is designed to prepare tomorrow's engineering leaders to solve the grand challenges facing society during the next century; through completion of components of the program, students have the opportunity to engage in research relating to their selected grand challenge, explore interdisciplinary coursework, gain an international perspective, engage in entrepreneurship, and give back to the community through service learning; for students who have been accepted as a fellow into the Engineering Grand Challenges Program and are working on completion of the program requirements. Requirements: acceptance to the Engineering Grand Challenges Program.

ENGR:4011 Engineering Grand Challenges Program Scholar 0 s.h.
The Engineering Grand Challenges Program is designed to prepare tomorrow's engineering leaders to solve the grand challenges facing society during the next century; through completion of components of the program, students have the opportunity to engage in research relating to their selected grand challenge, explore interdisciplinary coursework, gain an international perspective, engage in entrepreneurship, and give back to the community through service learning; for students who have been accepted as a scholar to the Engineering Grand Challenges Program and are working on completion of the program requirements. Requirements: acceptance to the Engineering Grand Challenges Program.

ENGR:4012 Engineering Grand Challenges Program Final 0 s.h.
The Engineering Grand Challenges Program is designed to prepare tomorrow's engineering leaders to solve the grand challenges facing society during the next century; through completion of components of the program, students have the opportunity to engage in research relating to their selected grand challenge, explore interdisciplinary coursework, gain an international perspective, engage in entrepreneurship, and give back to the community through service learning; for students who have been accepted to the Engineering Grand Challenges Program and are in the final semester of completing the program requirements. Requirements: acceptance to the Engineering Grand Challenges Program.

ENGR:5270 Finding Truth in a Sea of Big Data (and Social Media) 1 s.h.
How to detect and defuse misinformation from mainstream and social media; recognition of where misinformation occurs, what makes it misinformation, and provide statisticians or fellow scientists with a technical explanation of why a particular claim is nonsense; content is noncommittal of any political orientation since misinformation comes in all shapes and sizes from all corners of political spectrum. Requirements: engineering graduate standing.

ENGR:7270 Engineering Ethics 1 s.h.
Introduction to practical issues associated with being a responsible scientist; topics in responsible conduct of research in engineering and the sciences using case studies, presentations, and discussions with visiting speakers; conforms to mandates set by the Office of the Vice President for Research and the Graduate College to train graduate students and postdoctoral scholars/fellows in responsible conduct of research. Requirements: first-year graduate standing in College of Engineering.

ENGR:7604 Engineering Ethics for Post Docs 0 s.h.
Introduction to practical issues associated with being a responsible scientist; topics in responsible conduct of research in engineering and the sciences using case studies, presentations, and discussions with visiting speakers; conforms to mandates set by the Office of the Vice President for Research and the Graduate College to train graduate students and postdoctoral scholars/fellows in responsible conduct of research. Requirements: new postdoctoral research scholar/fellow in College of Engineering.

Engineering and Information Technology Courses

EIT:5120 Modern Automation and Control 3 s.h.
Study of sensor, motors, control, process automation, and internet of things (IoT).

EIT:5135 Modern Information Systems 3 s.h.
Introduction to enterprise information systems; RESTful service model, cloud service models, data storage models, big data considerations, network basics, security and privacy considerations; blockchain technology and its applications.

EIT:5150 Applied Artificial Intelligence 3 s.h.
Artificial Intelligence (AI), search and logic, data science and analysis, advanced machine learning and deep learning, digital manufacturing and design, signal processing and fault diagnosis, AI robotics and computer vision, and applications in engineering.

EIT:5155 Cyber-Physical Systems 3 s.h.
Introduction to modern "smart" systems providing intelligent monitoring, control, and coordination of societal, environmental, and business infrastructure; layered architecture for, relevant applications of, and projects involving conceptual design of cyber-physical systems.

EIT:5211 Machine Learning and Scientific Computing in Engineering 3 s.h.
Numerical methods in scientific computing; root problems and optimization; linear algebraic equations; eigenvalue problems; numerical differentiation and integration; interpolation and curve fitting; initial value and boundary value problems; machine learning in regression, classification, and clustering problems; Python programming and scikit-learn packages.

EIT:5216 Manufacturing Process and Modeling 3 s.h.
Fundamental science, modeling, and simulation technologies in materials processing; essential knowledge in automation and control of manufacturing systems; material removal processes, forming, microfabrication, and nontraditional material processes; finite element modeling/simulation of material processes; automation and control of manufacturing systems and processes.

EIT:5220 Advanced Control Engineering 3 s.h.
State-space representation of linear systems, equilibrium points, linearization, controllability, observability, stability, state feedback control, linear observer design, and separation principle.

EIT:5224 Mechanical Design and Realization 3 s.h.
Solid modeling, assemblies, drawings, geometric dimensioning and tolerancing, and basic engineering design process; use of analysis tools (e.g., Finite Element Analysis), fatigue and durability, optimization software.

EIT:5240 Kinematics of Modern Robotics 3 s.h.
Robotics motion, configuration space, and path planning.

EIT:5298 Mechanical Component Durability and Integrity Analysis 3 s.h.
System and component design, stress analysis, static failure, fatigue, fracture mechanics, vibration, materials science, and product life cycle.

EIT:5351 Cybersecurity 3 s.h.
Taxonomy of security threats and attacks; chain-of-trust principle; authentication, access control, and security domains; perimeter security and defense in depth; cryptographic protocols; key management and distribution; security assessment, internet of things (IoT) security and privacy issues.

EIT:5352 Modern Database Systems 3 s.h.
Introduction to contemporary database architectures: relational, key-value, document store, and graph-based; relative strengths and weaknesses of database architectures; enterprise scalability issues; data aggregation and visualization; project work involving use of modern database systems (e.g., MySQL, Redis, MongoDB, Neo4j).

EIT:5353 Big Data and Machine Learning 3 s.h.
Storage, management, and analysis of very large data sets; distributed file systems and object stores; MapReduce framework for processing large data sets; machine learning techniques; classification and clustering; pattern recognition; projects involving big data and machine learning frameworks (e.g., Apache Hadoop).

EIT:5380 Software Engineering Methods, Tools, and Frameworks 3 s.h.
Modern agile software development practices for cloud and web-based applications using state-of-the-art software engineering languages, tools, and technologies; software as a service (SaaS) architecture; software testing; introduction to enterprise application development frameworks; team-based project.

EIT:5381 Enterprise Software Engineering 3 s.h.
Modern DevOps practices and toolchains for enterprise information systems; scalable architecture; cloud services (e.g., SaaS, PaaS, LaaS); load balancing/autoscaling; identity management and security; performance monitoring and tuning; continuous integration and hot deployment.

EIT:5382 Human-Computer Interaction Design and User Experience 3 s.h.
Principles and guidelines for design and evaluation of human-computer interactions (HCI); design methodologies (e.g., participatory design, low- and high-fidelity prototyping); user interface technologies (e.g., input and output devices, interaction styles); quantitative and qualitative evaluation of user interfaces (e.g., expert reviews, usability testing).