# General Engineering Program

*Director of General Engineering*: Jessica Kuczenski

*Lecturers*: Jessica Kuczenski, Matthew Gaudet, Michael Sheppard

The School of Engineering, under the leadership of the director of general engineering, offers a major in general engineering, a minor in general engineering, and a minor in technical innovation, design thinking, and the entrepreneurial mindset. The bachelor of science degree in engineering is designed to provide students a technical degree with concentrations designed to meet the needs of the individual student. Not intended for a student who plans to work as a professional engineer, the general engineering degree allows a student to earn a technical degree while preparing for work or graduate study in fields such as law, medicine, business, or education.

## Requirements for the Major

In addition to fulfilling the undergraduate Core Curriculum requirements for the bachelor of science degree in engineering, students majoring in engineering must complete the minimum number of units and the specified requirements for their concentration.

Students majoring in engineering must complete a minimum of 189 units and the following requirements:

**English**

* ENGL 181

**Mathematics and Natural Science**

* MATH 11, 12, 13, 14
* AMTH 106 or MATH 22
* AMTH 108 or other approved upper-division mathematics elective
* CHEM 11 or 11T, 11L
* PHYS 31, 31L, 32, 32L, 33, 33L

**Engineering**

* ENGR 1, 1L
* ENGR 110
* BIOE 10 or BIOE 111
* CENG 41, 43, 43L
* COEN 10 and 10L (or other approved programming course and lab including COEN 11, CSCI 10, OMIS 30)
* ELEN 21, 21L, 50, 50L, 115, 115L
* MECH 10L, 11, 12L, 15, 15L, 121

**Design Sequence**

* ENGR 193
* ENGR 163 A&B
* ENGR 194, 195, 196

With permission, you may alternatively choose from one of the following options:

* BIOE 194, 195, 196
* CENG 192A, 192B, 192C, 193, 194
* COEN 194, 195, 196
* ELEN 194, 195, 196
* MECH 194, 195, 196

**Electives**

* 36 upper-division units defining a coherent concentration, selected in consultation with an academic advisor

## Requirements for the Minor in General Engineering

Students must fulfill the following requirements for a minor in general engineering:

* One course selected from COEN 10, 11, CSCI 10, OMIS 30, or other approved programming course together with the associated lab
* CENG 41
* ELEN 50, 50L
* MECH 10L, 12L, 121
* Two courses selected from BIOE 10, CENG 10, CENG 43, COEN 12, ELEN 21, ELEN 33, ELEN 115, MECH 11, MECH 15, MECH 140, together with associated labs
* A two-course sequence selected from BIOE 153 and BIOE 154, CENG 115 and CENG 118, CENG 121 and CENG 143, COEN 79 and any upper-division COEN course, ELEN 100 and ELEN 110, ELEN 115 and (ELEN 116, 127, or 164), MECH 122 and MECH 132, MECH 123 and MECH 125, together with associated labs

## Minor in Technical Innovation, Design Thinking, and the Entrepreneurial Mindset

*Program Coordinators:* Christopher Kitts, Jessica Kuczenski, Prashanth Asuri

To solve the complex and interdisciplinary technical challenges of the modern world, students must understand the entrepreneurial methods appropriate for harnessing technical innovation in order to create value through new devices, products, systems, processes, services, and ecosystems. This minor addresses this need by providing students with learning experiences that address product innovation, business fundamentals, and entrepreneurial thinking; in doing so, it leverages themes and concepts promoted through movements such as design thinking, lean development, and business modeling. In addition, an experiential learning activity in the context of the entrepreneurial development of a real engineering system is required. Participation in an elective component is also required.

This minor program is suitable for undergraduates in a wide variety of disciplines. It places an emphasis on an understanding of the user and the business environment for the design and implementation of technologies and solutions that are appropriate, affordable, and accessible for consumers in a variety of markets. Students who complete the program will be able to adapt both themselves and the organizations in which they work in a way that will allow them to remain competitive and relevant as global consumer trends continue to evolve.

## Requirements for the Minor in Technical Innovation, Design Thinking, and the Entrepreneurial Mindset

The minor includes requirements in the areas of Product Innovation and Prototyping, Business and Commercialization, and Design Thinking and Entrepreneurial Fundamentals. Students are also required to complete an experiential project putting these concepts into practice as well as participation in two elective activities. Multiple options are available for each of these requirements, affording students a great deal of flexibility in completing the minor.

Currently, the Minor offers an optional BioInnovation and Design track to provide students with an opportunity to focus their study of innovation and design/entrepreneurial thinking to medical and health care applications.

Completion of the minor requires satisfying the requirements listed below. Track-specific requirements are noted in each requirement category.

**Product Innovation and Prototyping (5 units minimum)**

Select one of the following options:

* Option A: MECH 144/L. Smart Product Design (5 units)
* Option B: Complete courses listed below (5 units):
  + ENGR 2. Introduction to Engineering Design and Prototyping (2 units)
  + ENGR 110. Community-Based Engineering Design (3 units)

**Business and Commercialization Fundamentals (4 units minimum)**

Select one of the following options:

* Option A: BUSN 70. Contemporary Business Issues (4 units) or BUSN 170. Contemporary Business for Nonmajors (5 units)
* Option B: BIOE 106. Design Control for Medical Devices (4 units)
* Option C: ENGR 173. Introduction to Business Fundamentals (1 unit) plus any three additional 1-unit courses from the approved Business and Commercialization Fundamentals list below:
  + ENGR 152. Regulatory Pathways for Medical Devices and Technologies (1 unit)
  + ENGR 156. Conceptualizing Innovations in Health Care (1 unit)
  + ENGR 164. Financing New Ventures (1 unit)
  + ENGR 167. Go To Market Strategy (1 unit)
  + ENGR 168. Legal Considerations for New Ventures (1 unit)
  + ENGR 174. Financial Statements and Decision Making (1 unit)
  + ENGR 175. Business Model and Plan Development (1 unit)
  + ENGR 176. Introduction to Technical Marketing (1 unit)
  + ENGR 178. Intellectual Property for Engineers (1 unit)

BioInnovation and Design Track: Must complete Option B or Option C including ENGR 152 and ENGR 156.

**Design Thinking and Entrepreneurship Fundamentals (4 units minimum)**

Select one of the following options:

* Option A: MGMT 164. Introduction to Entrepreneurship (5 units)
* Option B: BIOE 111. Introduction to Healthcare Innovation (4 units) or (ENGR 121. BioInnovation I (2 units) and ENGR 122. BioInnovation II (2 units))
* Option C: Four 1-unit courses from the approved Design/Entrepreneurial Thinking list below:
  + ENGR 151. Design Controls for the Medical Device Industry (1 unit)
  + ENGR 153. Risk Management during Medical Device Design and Development (1 unit)
  + ENGR 154. Usability Engineering for Medical Devices (1 unit)
  + ENGR 162. Thinking in Systems (1 unit)
  + ENGR 165. Creativity: The Art of Innovation (1 unit)
  + ENGR 166A/B. Introduction to Design Thinking (1 unit each)
  + ENGR 169A/B/C. Social Entrepreneurship (1 unit each)
  + ENGR 171A/B. Opportunity Recognition I and II (1 unit each)
  + ENGR 172A/B. Applied Entrepreneurship I and II (1 unit each)
  + ENGR 177. Customer Ethnography (1 unit)
  + ENGR 179. Corporate Intrapreneurship (1 unit)

BioInnovation and Design Track: Must complete Option B or Option C including ENGR 151, ENGR 153, and ENGR 154.

**Experiential Activity (5 units minimum)**

An academically supervised, hands-on engineering activity that includes entrepreneurially oriented tasks relating to the development of an appropriate business/enterprise model for a real engineering product/system.

Select one of the following options:

* Option A: ENGR 163A&B. Engineering and the Entrepreneurial Mindset (total of 1 unit over 2 quarters), performed in conjunction with a senior project course sequence (6–10 units)
* Option B: ENGR 163A&B. Engineering and the Entrepreneurial Mindset (total of 1 unit over 2 quarters), performed in conjunction with ENGR 199. Directed Research (6 units) performed with a hands-on engineering component
* Option C: BUSN 145. Entrepreneurship Practicum (5 units) performed as part of a placement that includes a significant technology focus relating to design/development, approved by the minor program coordinator

BioInnovation and Design Track: May complete any Option. Experiential activity must involve a relevant medical device or health care innovation project approved by minor and track program coordinator(s).

**Elective Component**

Participation in additional Pathway, course, or co-/extra-curricular activities within the School of Engineering’s program in innovation and entrepreneurial thinking. Complete any two of the following program opportunities:

* Option A: Complete the Design Thinking Pathway with an essay theme that specifically emphasizes a topic relating to developing a deep understanding of customer/market needs and opportunities and capitalizing on this to create value through the design of a technical system.
* Option B: Participate in selected co-extracurricular activities approved in advance by the minor program coordinator. These may include experiences such as two significant extra-curricular design challenges, a workshop, a mini-course, etc. (such activities may not have been used for credit in any other course).
* Option C: Complete an independent study project relating to technical entrepreneurship, supervised by a faculty member and approved in advance by the minor program coordinator.
* Option D: Complete an additional 3 units of coursework from approved courses in the Engineering Innovation and Entrepreneurship program (shown below). Courses chosen from this list cannot be doubly used to satisfy the Design Thinking pathway
  + ENGR 16. Values in Technology (4 units)
  + ENGR 19. Ethics in Technology (4 units)
  + ENGR 110. Community-Based Engineering Design (3 units)
  + ENGR 140. Diversity and Innovation in STEM (4 units)
  + ENGR 141. Innovation Theology (4 units)
  + ENGR 145. Innovation, Entrepreneurship, and the Evolution of Silicon Valley (4 units)
  + ENGR 161. Globalization and the Cultures of Innovation and Entrepreneurship (4 units)
  + BUSN 6/6H. Business Ethics (4 units)
  + PHIL 26. Ethics in Business (4 units)

## Grand Challenge Scholars Program

*Program Coordinator:* Jessica Kuczenski

The Grand Challenges Scholars Program (GCSP) at SCU is designed to attract students who are excited about pursuing answers to challenges that face humanity and making the world a better place for all. The GCSP is a nationally recognized program offered as part of the National Academy of Engineering (NAE). With this program, NAE has sparked ‘a global movement’ driven by its aspirational vision which calls for engineering to serve people and society by working towards the “continuation of life on the planet, making our world more sustainable, secure, healthy, and joyful”[[1]](#footnote-0). This aspirational vision is well-aligned with SCU’s Jesuit Mission and values, empowering our students to improve and enhance their leadership skills and increase their social/global awareness.

## Requirements for the Grand Challenge Scholars Program

The SCU GCSP program is open to all students in good academic standing. Criteria for selection are founded upon a student’s demonstrated willingness to work and commit themselves to the elements of the GCSP. Specifically, the student must meet the following:

* Be a student in “good academic standing”, e.g. a student enrolled for 12 or more units and maintains a cumulative grade point average of at least 2.0 based on all courses taken at Santa Clara University, as per definition in chapter 8 of this bulletin.
* Create an application for the SCU Grand Challenges Scholar Program including:
  + Personal essay (no more than 1 page) on motivation to complete the SCU Grand Challenges Scholar program and the specific GC challenge they want to address.
  + Recommendation(s) from at least one faculty member/mentor. This letter should address the strengths, talents and motivation of the student that will sustain him/her in completing the GCSP components. Ideally, the mentor will have first hand knowledge of the applicant’s work habits, persistence, organizational abilities, and independence, all essential to identifying and completing activities to fulfill GCSP requirements.
  + Endorsement from the student’s academic advisor (or department chair) who is in a position to gauge whether admission to this program is recommended based on current GPA and courses to come.
  + A proposed Grand Challenges faculty mentor. Initially, the program director and the Grand Challenges Steering Committee will serve as ‘interim’ mentor(s) for all students interested in the program to help guide them and to help identify a mentor that is linked to their project area. Every effort will be made to find a faculty mentor that is well suited for working with interdisciplinary undergraduate students.
  + A proposed Grand Challenges Plan Schedule that:
    - Outlines how the student plans to fulfill each of the five Grand Challenges competency areas as part of their program of study (detailed in the [GCSP Experiences](#rul5cskrjjky) section below), along with an explicit statement that connects the five competencies to a GCSP theme (Health, Sustainability, Security, Joy of Living) or a particular Grand Challenge (one of the fourteen). This plan is subject to change as the student works through the components and consults with his/her advisor.
    - Is feasible to be completed in the time remaining prior to the student’s graduation.
* The application will be submitted to the GCSP Director via email to [jkuczenski@scu.edu](mailto:jkuczenski@scu.edu).

**GCSP Experiences**

Each Grand Challenges plan must satisfactorily address the five Grand Challenges competencies required by the GCSP. Furthermore, scholars will work to connect their plan and GC experiences thematically through a specific Grand Challenge (one of the fourteen) or a chosen GCSP theme (Health, Sustainability, Security, Joy of Living). *Please note that any single experience cannot be used to demonstrate multiple competencies in the GCSP, e.g. senior design capstone cannot be used to fulfill both Talent and Interdisciplinary competencies, though longer term meta experiences could be parsed and used to demonstrate multiple competencies.* Details for each Grand Challenge competency is as follows:

**1. Talent**

The goal for this requirement is ensuring that depth of understanding and exposure to at least one Grand Challenge Area is attained by each scholar. Therefore, all GCSP scholars will be required to participate in an approved research or project-based experience related to a Grand Challenge area. Research and projects can be individual or team based with a scope that is commensurate to the number of scholars involved. This project will have a sustained duration of one academic year or other similar significant time period, such as a full time summer project. An estimated total of greater than 150 hours is expected.

Some examples of the experiences that may support student development of the Talent Competency include participation in formal undergraduate research programs, capstone design projects, or other significant research experiences such as Research Experiences for Undergraduates (REUs) sponsored by NSF and the like. To be an approved project, the scholar must submit a description of the project including the scope, anticipated learning objectives, and a narrative of the broader impacts of the student’s participation in the project.

**2. Multicultural**

Multicultural awareness is necessary for working effectively in an increasingly interdependent world. Participating in this competency area will deepen a student’s consciousness and motivation to bring technical knowledge to bear on global problems. This experience could be overseas or in an underserved domestic community. It may also be fulfilled through core curriculum as part of the Experiential Learning for Social Justice coursework. As a Jesuit University, SCU has a broad array of opportunities available to the students through our [Global Engagement Office](https://www.scu.edu/globalengagement/). A list of these opportunities include:

* Study Abroad
* Global Fellows Internship
* Global Social Benefit Fellowship
* Immersion experiences
* Registered Student Organizations, including Engineers without Borders, Engineering World Health or any other RSO with a global or underserved community partnership

To ensure significant breadth and depth of experiences, credit for the Multicultural GC competency assumes a minimum of 6 weeks full-time experience or at least one quarter (10 weeks) of part-time experience.

**3. Interdisciplinary Experience**

Bridging engineering to other disciplines is essential for solving the NAE Grand Challenges. SCU experiences, as part of its Jesuit liberal arts background, are designed to build connections amongst fundamental science, mathematics, and engineering, but also amongst different fields of engineering, the arts, humanities, and social sciences, among others. All SCU students spend at least ~25% of their credit hours on liberal arts coursework as part of our Core Curriculum and must complete a Pathway. Pathways are clusters of courses with a common theme that provide an opportunity to study that theme from a variety of disciplinary or methodological perspectives. The purpose of the Pathway is to perceive connections, complexities, and relationships among ideas and a student’s educational and life experiences.

All GCSP scholars will be required to fulfill the Interdisciplinary competency through completion of **two** of the following:

* Successful completion of a Pathway, including passing coursework (3 approved courses) and successful submission and acceptance of the Pathway essay. Both chosen coursework and the Pathway essay must be explicitly connected not only to their Pathway theme, but also to their chosen GC theme, which will first be approved by the GCSP Director prior to formal submission of the essay to the University. Suggested Pathway themes include ‘Applied Ethics’, ‘Design Thinking’, ‘Food, Hunger, Poverty & Environment’, ‘Global Health’, ‘Leading People, Organizations & Social Change’, ‘Sustainability’, and ‘Values in Science & Technology’, though any Pathway can be completed with Director approval.
* Participation on a multi-disciplinary design project at the capstone level or other academic year-long sustained participation. Examples of this include our senior design capstone projects as well as significant design project competitions such as Solar Decathlon, Tiny House, and others that have been offered in the recent past.
* Participation in design projects through Hubs or Labs on campus such as the Frugal Innovation Hub, the BioInnovation and Design lab, or the Robotics Systems Lab, or through student organizations such as Engineers Without Borders, Engineering World Health, etc. Design projects completed should ensure significant breadth and depth of experiences. Therefore, a minimum of 6 weeks full-time experience or at least one quarter (10 weeks) of part-time experience is required.
* Successful participation in an explicitly interdisciplinary project-based course or other technical elective (minimum 4 units)
* Double-major or minor in a non-engineering discipline

**4. Social Consciousness**

The purpose of this competency area is to work with the people and organizations that are most strongly affected by the Grand Challenges now and in the future. In addition, a sense of caring and compassion for all people of all classes and abilities is an important attribute of someone who will be designing solutions that affect many different types of people. Each GCSP scholar will participate in a significant service oriented activity which requires the equivalent of at least 30 hours of community service work and which may potentially include:

* Logged community service with reflection essay connecting service to their selected GC theme
* Participating in an approved [Global Engagement Office](https://www.scu.edu/globalengagement/) program including Engineers without Borders or an Immersion Experience
* Completing their senior design capstone project or other research project with a substantial community engagement component
* Participation in projects led by the Frugal Innovation Hub, the Miller Center for Social Entrepreneurship or other Hubs/Labs on campus with significant community engagement component
* Participation in internships for global service organizations
* Completion of coursework in social action which includes our Experiential Learning for Social Justice, Cultures & Ideas, and Ethics core curriculum areas
* Successful completion of other community outreach experiences or coursework

**5. Viable Business/ Entrepreneurship**

The combination of entrepreneurship and innovation is central to promoting growth and technological development in our society. Santa Clara University recognizes the value in engaging students in the process of translating innovation into practical solutions that make a difference in people’s lives through entrepreneurship as it has two related minors offered through the Leavey Business School and the General Engineering program within the School of Engineering. Furthermore, SCU has existing Centers of Distinction including the Miller Center for Social Entrepreneurship and the Center for Innovation and Entrepreneurship. In addition, SCU is a long-time member of the Kern Engineering Entrepreneurial Network (KEEN) with faculty dedicated to the inclusion of entrepreneurial thinking in their offered coursework and design experiences. Finally, SCU often offers hackathons and pitch competitions which feature entrepreneurial themes throughout the academic year.

We will leverage these curricular and extracurricular programs to ensure students understand and display a basic level of achievement in this Grand Challenges competency area. Unless specifically stated otherwise below, significant breadth and depth of experiences for these activities is required to be a minimum of 10-hrs of focused work with a submitted summary reflection of learning gains from each activity and its connection to the scholar’s chosen GC theme. Students are required to complete one of the following:

* Successfully complete a minimum of twelve units from the Entrepreneurship or Technical Innovation, Design Thinking, and Entrepreneurial Mindset minor offered through the Business or Engineering School or other mentor-approved coursework.
* Work/Intern at a start-up or early stage venture that addresses a Grand Challenges Area, minimum of part-time work (5-10 hrs per week) for duration of a 10-week quarter.
* Participate in competitions and/or entrepreneurship events within or outside of SCU.
* Participate in SCU’s Innovation Fellows Program (UIF) leadership circle (via Stanford Epicenter) for one academic year.
* Pursue any other project that displays a substantial level of commitment and initiative on the part of the student to investigate and understand entrepreneurial thinking.

## Combined Bachelor of Science and Master of Science Program

General Engineering offers a combined degree program leading to a bachelor of science and a master of science in one of the school’s MS programs. Under the combined degree program, an undergraduate student begins taking courses required for a master’s degree before completing the requirements for a bachelor’s degree and typically completes the requirements for a master of science within a year of completing the bachelor’s degree.

Undergraduate students admitted to the combined degree program are required to enroll in the program between February of their junior year and December of their senior year. Students in this program will receive their bachelor’s degree after satisfying the standard undergraduate degree requirements. To earn a master’s degree, students must fulfill all requirements for the degree, including the completion of 46 units of coursework beyond that applied to the bachelor’s degree. The program of studies for the master’s degree may include up to 20 units taken while enrolled as an undergraduate student; however, no individual course can be used to satisfy requirements for both the bachelor’s degree and master’s degree.

## Lower-Division Courses

### 1. Introduction to Engineering

This course provides an introduction to engineering, including fundamentals of engineering study, different engineering disciplines, and interdisciplinary aspects of engineering. This course investigates the connection between science, technology, and society, and also illustrates the extent to which engineering impacts the world. The course also exposes students to entrepreneurship, engineering professionalism, the growth mindset, emerging markets, ethics, and civic engagement. ENGR 1 and ENGR 1L together fulfill the Science, Technology & Society core requirement. (1 unit)

### 1L. Introduction to Engineering Laboratory

The laboratory will provide students with hands-on experience of engineering design and open-ended problem solving. The lab focuses on introducing aspects of the different engineering disciplines and allows students to gain experience with each of the engineering disciplines and reflect on learning gains with teamwork, communication, and engineering skills. Engineering designs will be framed to include the impact of design solutions/technologies on society and will be developed in a team-based environment utilizing visuals, written text, and oral presentation. ENGR 1 and ENGR 1L together fulfill the Science, Technology & Society core requirement. (1 unit)

### 2. Introduction to Engineering Design and Prototyping

Introduction to prototyping in the engineering design framework. Students will work to design and prototype projects on four major pieces of Maker Lab equipment, which they will be trained to use. Prerequisite: ENGR 1L. (2 units)

### 15. Environmental Quality Engineering

Behavior of chemicals in the environment. Environmental protection strategies. Environmental impact assessment. Risk analysis and economic considerations. Discussion of local, regional, and global environmental problems, and alternative solutions. For non-engineering majors. Prerequisite: MATH 6 or equivalent. (4 units)

**16. Values and Technology**

This course will draw upon the resources of Catholic theology and African Ubuntu theology to help students explore their own perspectives on the purpose and use of technology in the modern world. Intended for engineering students and others who are interested in entering into the design and development of technology, this course will invite students to develop their own set of tech values that inform how they will both use and design contemporary technology, by exploring foundational questions about the nature of humanity, society, and creation. (4 units)

### 19. Ethics in Technology

Making the case for constructive ethical application of the most powerful technologies of the 21st century. Normative, principle-based ethical analysis of current and emerging technology in arenas including information, energy, biotech/medicine, military science, robotics, and agriculture. ENGR 19 satisfies the Ethics Core requirement. (4 units)

### 20. Topics in Robotics

Participate in a project-based, hands-on engineering project in a team-based environment. Gain exposure to sensing, actuation, and control techniques and components in the process of developing a robotic system or subsystem. Prerequisite: Instructor permission required. (1 unit)

### 25. Sustainable Energy Projects

Students learn the fundamentals of sustainable energy in a wide range of fields and carry out projects in these areas. Activities are normally associated with the Latimer Energy Scholars Program. May be repeated for credit. Prerequisite: Instructor permission required. (1–2 units)

### 60. Sustainable Electric Energy

This course explores the twofold 21st-century challenges of the use and conservation of electric energy, and the sustainable generation of electric energy, primarily through the use of photovoltaic cells. The course includes a study of issues relating to the environment, economics, politics, and societal impact. Although physical and mathematical studies and analyses are a part of the course, no background in these areas is required beyond algebra. ENGR 60 satisfies the Science, Technology & Society Core requirement. (4 units)

### 85. Special Topics in Engineering

Subjects of current interest. May be taken more than once if topics differ. (1–4 units)

### 90. Engineering Competition Workshop

Workshop to develop aspects of an engineering school sponsored entry into an external competition (examples include Solar Decathlon and Tiny House). May include design, communication, construction, research, analysis, planning, documentation, fundraising, and other activities. Students will meet together to share information, brainstorm, collaborate, and make decisions, and will also work independently or in small teams in focused areas. (1 unit)

### 91. Architecture Workshop

Students will explore aspects of architecture with a particular emphasis on design related to an external contest. General topics may include design principles; form and function; space utilization; natural and artificial lighting; BIM and architectural documentation; and texture and color. Special topics may include sustainable building materials, LEED certification process, passive solar design, building integrated photovoltaics, and modular building techniques. (2 units)

### 98. Independent Study

Independent study of an approved engineering problem and preparation of a suitable project report. (1–4 units)

## Upper-Division Courses

### 110. Community-Based Engineering Design

Student teams are partnered with a local community business or organization and complete a design project from problem identification through final prototype. Course focuses on “hands-on” experience in project management, building cross-disciplinary team skills, and prototyping (training and use of the SCU Maker Lab included). This course is open to students at all levels and all majors (engineering or non-engineering). Come make a real difference in a real community! Satisfies the Civic Engagement Core requirement. (3 units)

### 111. STEM Outreach in the Community

This course examines challenges surrounding STEM (Science, Technology, Engineering, and Math) education such as funding, diversity, and accessibility. Students develop or enhance STEM curricular materials and explore pedagogical techniques specific to working with youth from marginalized communities. Students taking ENGR111 and ENGR 111L will satisfy the ELSJ Core requirement. Corequisite: ENGR 111L. (2 units)

### 111L. STEM Outreach in the Community Lab

Students lead engineering-focused STEM activities with K–12 students at a community partner’s off-campus site. No specific engineering expertise is required or expected. Corequisite: ENGR 111. (1 unit)

### 121. BioInnovation I: Opportunity Identification and Concept Generation

First course of the two-course sequence introduces students to health care and medical device technology innovation for advanced and emerging markets. Students work in teams on problem identification and assessment as well as scrutinization of clinical impact, product feasibility, and commercial viability to define the needs and requirements of new technology products to address unmet or poorly met health care needs. Prerequisite: sophomore to senior standing or instructor consent. ENGR 121 and ENGR 122 together satisfy the Science, Technology & Society Core requirement. (2 units)

### 122. BioInnovation II: Product Development Strategy and Prototyping

Second course of the two-course sequence takes students through the product development stage of medical device innovation process. Students work in teams on the design, development, and prototyping of engineering solutions that satisfy the needs identified in ENGR 121, as well as formulation of strategies to ensure regulatory compliance and commercialization success. ENGR 121 and ENGR 122 together satisfy the Science, Technology & Society Core requirement. Prerequisite: ENGR 121. (2 units)

### 125. Advanced Sustainable Energy Projects

Students study advanced concepts in sustainable energy and carry out complex projects, typically in a team environment. Activities are normally associated with the Latimer Energy Scholars Program. May be repeated for credit. Prerequisites: ENGR 25 and instructor permission required. (1–2 units)

### 135. Humanitarian Engineering

Engineering for social benefit. Introduction to the following concepts: humanitarian and frugal innovation, design for empathy, needs assessment, impact evaluation, and social entrepreneurship. (1 unit)

### 136. Frugal Innovation Projects for Social Benefit

Students explore and apply the 10 core competencies of frugal innovation through case studies applied to mobile applications, low-cost diagnostics, frugal habitat, last-mile distribution and micro entrepreneurship, and learn how to design technologies and business models for social benefit. Student projects focus on real-world implementations with social enterprises in emerging markets. Prerequisite: Junior standing or sophomores with instructor consent. (2 units)

### 138. Critical Tools for Social and Environmental Projects

This class offers vital tools for completing projects in unfamiliar communities and/or cultures. Students will learn how to read and understand the human and environmental ecosystem where they and their projects are immersed, and incorporate this information into their design process to develop solutions that are socially, economically, and environmentally appropriate. Students will also learn how to implement a quick "need assessment evaluation" to uncover the scope, depth, impact, and local perception of the need they will solve, while familiarizing themselves with approaches and tools for problem-solving and innovation. Prereq: junior standing. (2 units)

### 140. Diversity and Innovation in STEM

This course focuses on the intersection of diversity, inclusion, and product or service innovation. Build understanding and skills to work with diverse perspectives and competencies from intersectionalities of race, gender, religion, region, and other dimensions of diversity, and derived from historical American systemic ideologies of individual freedom and success within a hierarchy as an individualistic mindset and of social responsibility with justice for all as a relational mindset in oneself, and in other individuals, organizations, systems, and cultures. Learn entrepreneurship and design thinking prototyping techniques while working in teams on innovation challenges that can change the world. Students will explore user-centered design by developing and applying design processes and strategies in hands-on exercises, design critiques, discussions, lectures, and readings. ENGR 140 satisfies the Diversity Core requirement. (4 units)

### 141. Innovation Theology: An Introduction

The course equips future innovators with the ability to discern more compelling answers to where innovations and value are needed and why by cultivating confidence in applying theological inquiry to innovation. ENGR 141 satisfies the Religion, Theology & Culture 2 Core requirement. (4 units)

### 143H. Science, Religion, and the Limits of Knowledge

The limits of scientific knowledge are examined in the framework of nonlinear system theory, metamathematics, and modern physics. The technical background developed in the course is used as a basis for exploring the relationship between science, aesthetics, and religion. Particular emphasis is placed on the rationality of faith, and on controversial questions where the views of scientists and theologians appear to conflict. ENGR 143 satisfies the Religion, Theology & Culture 2 core requirement. Prerequisite: MATH 12 or 31. (4 units)

### 145. Innovation, Entrepreneurship, and the Evolution of Silicon Valley

This course will explore technological innovation by studying the evolution of technologies and industries in Silicon Valley. We will review the development of fundamental technologies such as vacuum tubes, semiconductors, and biotechnology, and systems such as radar, communications, aerospace, personal computing, the internet, social media and platforms. This approach will help students to understand 1) the defining features of this region and how it has continued to lead in global technology development even as the fundamental technologies have changed, and 2) the complexity of the innovation process and the influence of the public sector, academia, investors, and other entities on innovation and entrepreneurship. (4 units)

### 151. Design Controls for the Medical Device Industry

Introduces process-based frameworks required in the design and development of biomedical products to ensure that they meet user requirements and safely perform their intended use. Student teams use real-world medical device examples to examine product requirements, and apply agile/lean engineering methods to product verification and validation test planning. Frameworks mastered through this course will give students a practical toolkit of robust methods to ensure product quality and regulatory compliance. Prerequisite: sophomore to senior standing. (1 unit)

### 152. Regulatory Pathways for Medical Devices and Technologies

Introduces U.S. FDA and European regulatory pathways for medical device and diagnostic products. Students will explore regulatory requirements for devices including software and for drug-device or biologic-device combination products. Examples of FDA-industry collaboration in the advancement of regulatory science will be provided from the emerging fields of personalized medicine and devices using artificial intelligence. Student teams will classify a medical device, assess its U.S. FDA regulatory pathway, and estimate the development program that will be required to gain regulatory approval or clearance. Prerequisite: sophomore to senior standing. (1 unit)

### 153. Risk Management During Medical Device Design and Development

This course introduces a process-based approach for risk management applied to medical devices. Students will explore different types of risk analysis and their applicability. While the regulatory requirements for risk management are explained, the course focus is to provide students with perspective on the value that an effective, compliant risk management program brings to all stakeholders throughout the product life cycle. Student teams will participate in a simulated medical device development project, and conduct the appropriate risk management activities during the simulation. Prerequisite: sophomore to senior standing. (1 unit)

### 154. Human Factors and Usability Engineering for Medical Devices

Introduces human factors/usability engineering principles imperative to the evaluation of user interfaces (UI) in medical devices. Students will explore medical device use error case studies to learn how to assess the ways people perceive, interpret, and manipulate devices, as well as how the device receives user input and responds. Student teams will conduct a Usability Engineering Validation Study project, in which a device is assessed using various analytical techniques. Frameworks applied through this course will give students a practical tool kit of robust methods to evaluate product safety and effectiveness. Prerequisite: sophomore to senior standing. (1 unit)

### 156. Conceptualizing Innovations in Health Care

While the rewards of innovative health care products and services are lucrative, new product development for the healthcare industry is inherently complex and resource intensive, and often fraught with risks. Using relevant case studies, this course introduces students to the processes and strategies used by health care firms to develop new product innovations that efficiently address user needs and pain points, and thereby enjoy a higher degree of commercialization success. Prerequisite: sophomore to senior standing. (1 unit)

### 160. Nanotechnology and Society

This course examines the fundamental scientific and technological underpinnings of the important new field of nanotechnology; how both the understanding and the technological capabilities have evolved over the past century; and how nanotechnology proposes new applications that can address social and economic goals. An appreciation of the interaction between these goals and the evolution of the technology will be central to the course. Students will develop critical thinking about the prospects for nanotechnology in order to be able to assess the relevant ethical and social issues, and also the possibility and/or likelihood of the development of specific applications. ENGR 160 satisfies the Science, Technology & Society Core requirement. (4 units)

### 161. Globalization and the Cultures of Innovation and Entrepreneurship

This course introduces students to the skills, practices, and processes for understanding and managing innovation and entrepreneurship activities that span cultures throughout the world. These cultural challenges include developing a deep understanding of the needs of customers in emerging markets, producing goods and services with global teams, and outsourcing manufacturing operations. ENGR 161 satisfies the Cultures & Ideas 3 Core requirement. (4 units)

### 162. Thinking in Systems

Systems thinking represents an important tool for analysis and problem-solving, especially when collaborating with others from diverse perspectives, both within and outside of engineering disciplines. The course will introduce students to basic concepts of thinking in systems by providing exposure to and experience with modeling methods from both systems dynamics and general systems theory. (1 unit)

### 163A. Engineering and the Entrepreneurial Mindset I

This is the first course in a two-course sequence taken in conjunction with a senior capstone course and relates elements of the capstone experience to themes that are fundamental to entrepreneurial thinking. Activities are framed from the point of view of a business model in which explicit elements of an engineering enterprise are defined, such as customer segments, the value proposition, etc. To be immediately followed with ENGR 163B. (0.5 unit)

### 163B. Engineering and the Entrepreneurial Mindset II

This is the second course in a two-course sequence taken in conjunction with a senior capstone course and relates elements of the capstone experience to themes that are fundamental to entrepreneurial thinking. Activities are framed from the point of view of a business model in which explicit elements of an engineering enterprise are defined, such as customer segments, the value proposition, etc. Taken immediately following ENGR 163A. (0.5 unit)

### 164. Financing New Ventures

An introduction to the basics of obtaining initial and early-stage financial support for a new entrepreneurial venture. The course reviews financial sources, pitch decks, term sheets, negotiation tactics, and how to create the perfect pitch for obtaining financing. (1 unit)

### 165. Creativity: The Art of Innovation

Creative confidence is foundational to human-centered design thinking, innovation, and entrepreneurship. In this interdisciplinary course, students strengthen skills in creativity and innovation through empathy gathering, photography, storytelling, improvisation, music, art, and prototyping. (1 unit)

### 166. Introduction to Design Thinking A

The basic principles of design thinking, especially as applied to the three essentials for innovating success - user desirability, technical feasibility and business/economic viability. Explores techniques relating to themes such as deep customer understanding, creative brainstorming, and active prototyping. These topics are applied in the context of a team-based project conducted through the ENGR 166 A and B course sequence (1 unit).

### 166. Introduction to Design Thinking B

The basic principles of design thinking, especially as applied to the three essentials for innovating success - user desirability, technical feasibility and business/economic viability. Explores techniques relating to themes such as deep customer understanding, creative brainstorming, and active prototyping. These topics are applied in the context of a team-based project conducted through the ENGR 166 A and B course sequence. Prerequisite: ENGR 166A (1 unit).

### 167. Go To Market Strategy

This course for engineering undergraduate students reviews essential concepts for new entrepreneurial ventures to include the customer discovery phase, channels of distribution, strategic partners, and monetary metrics. (1 unit)

### 168. Legal Considerations for New Ventures

This course for engineering undergraduate students identifies legal risks facing new ventures and reviews techniques and approaches on how to reduce these risks while accomplishing business or engineering goals. (1 unit)

### 169A. Social Entrepreneurship: Organizational Design

Presents business models and social impact models as key to the financial sustainability and growth of social enterprises. Explains how social enterprises articulate mission alignment, value chain design, customer-focus, resource mobilization, and partnership strategies to create social impact. Uses business and impact model canvases to analyze real world cases.(1 unit)

### 169B. Social Entrepreneurship: Entrepreneurial Leadership

Examines the role of entrepreneurial leadership in creating social impact and leading social change. Identifies key leadership competencies and investigates how these are applied to lead social enterprises. Surveys this leadership in the global social enterprise movement. (1 unit)

### 169C. Social Entrepreneurship: Scaling Impact through Innovation

Outlines strategies for scaling that link social impact assessment with impact investment. Examines the role of digital technologies in scaling strategies, and the importance of accountability practices in securing investment capital. Surveys the diversity of impact investment products. (1 unit)

### 170. Improv for Engineers

Through theater games, improvisation, warm-up exercises, monologs, and scenes, students will learn the basics of Stanislavski’s method of physical actions to learn the basic principles of acting and in the process increase self-confidence and the ability to collaborate. (1 unit)

### 171A. Product Opportunity Assessment

This course focuses on identifying and assessing opportunities for new products and services. Based on the principles of design thinking, it addresses the identification of problems by reviewing methods for understanding the needs and motivations of the customer. It also reviews the development of a validated and solution-independent need statement. (1 unit)

### 171B. Product Prototype to Test

This course introduces product prototyping strategies to allow students to test their design concepts with customers with the objective of validating assumptions regarding customer need and desired functionality/features. Prerequisite: ENGR 171A or instructor permission. (1 unit)

### 172A. Applied Entrepreneurship I

This is the first course in a two-course sequence in which students will explore an emerging technical market and develop specific viable business models to execute within the SCU educational program. Students will explore applications for the selected technology, identify customers/markets, and define a sustainable business model. Preferential admission may be given to students who have taken other courses in the school’s innovation and entrepreneurship program. Prerequisites: sophomore standing or above, and instructor permission required. (1 unit)

### 172B. Applied Entrepreneurship II

This is the second course in a two-course sequence in which students will explore an emerging technical market and develop specific viable business models to execute within the SCU educational program. Students will explore applications for the selected technology, identify customers/markets, and define a sustainable business model. Prerequisites: ENGR 172A and instructor permission. (1 unit)

### 173. Introduction to Business Fundamentals

This course serves as an introduction to fundamental business topics, to include basic economics, business forms and functions, reading simple financial statements, basic marketing concepts, and management concepts. The course includes participation in an online business simulation. Prerequisite: sophomore to senior standing only. (1 unit)

### 174. Financial Reporting and Decision-Making

This course develops an understanding of financial statements and how they may be analyzed to assess the performance of an enterprise. The course also reviews capital markets and associated decision making for corporate operation. A business simulation allows students to apply principles of management, operations, marketing, and accounting to a business scenario. Prerequisite: ENGR 173 or instructor permission. (1 unit)

### 175. Business Model and Plan Development

This course introduces students to the Business Model Canvas as a framework for describing and organizing the operational elements of a functional enterprise, whether it is a commercial or nonprofit entity. Topics include identifying customers and explicitly stating the value proposition, identifying value delivery mechanisms, articulating strategic partnerships, identifying key resources, and describing anticipated cash flow. (1 unit)

### 176. Marketing Strategy

This course reviews the strategic segmenting/targeting/positioning and practical messaging skills used in product marketing and thought leadership positions, which are core to entrepreneurial technology ventures. Specific topics include an overview of core marketing skill sets, practical examples of successful market segmentation and target selection, best practices for positioning and messaging creation, competitive landscape modeling and developing differentiation, translating customer requirements into effective positioning/messaging, and wholesale market (re-)definition. (1 unit)

### 178. Intellectual Property for Engineers

This course for engineering undergraduate students provides an overview of United States intellectual property (IP) laws, focused specifically on how those laws impact and apply to engineers. (1 unit)

### 179. Intrapreneurship

Intrapreneurship is a form of corporate entrepreneurship, and it focuses on the needs of an established organization (unlike a startup) to create an innovative business opportunity within the existing structure of the organization. (1 unit)

### 180. Marine Operations

Introduction to the design, operation, deployment, piloting, and safety issues involving the use of underwater robots. Prerequisite: Instructor permission required. (1 unit)

### 181. Advanced Marine Operations

Technical operation, maintenance, and advanced piloting of underwater robots. Crew management. Operational and safety procedures. Prerequisite: Instructor permission required. (1 unit)

### 185. Special Topics in Engineering

Subjects of current interest. May be taken more than once if topics differ. (1–4 units)

### 188. Co-op Education

Practical experience in a planned program designed to give students practical work experience related to their academic field of study and career objectives. Satisfactory completion of the work assignment includes preparation of a summary report on co-op activities. P/NP grading. May not be taken for graduate credit. (2 units)

### 189. Co-op Technical Report

Credit given for a technical report on a specific activity such as a design or research project, etc., after completing the co-op assignment. Approval of department advisor required. Letter grades based on content and quality of report. May be taken twice. May not be taken for graduate credit. Prerequisite: COEN 188. (2 units)

### 193. Introduction to Senior Design Project

Junior preparation for senior project. An introduction to project requirements, team management, and project management. Consideration of career documentation and networking. Tentative project selection. (1 unit)

### 194. Senior Design Project I

Specification and initial investigation of an engineering project, selected with the mutual agreement of the student and the project advisor. The design process begins, including problem formulation, research, and preliminary design and analysis. Initial draft of the project report with oral presentation. (2 units)

### 195. Senior Design Project II

Continued design and construction of the project, system, or device. The design process continues, including design analysis, testing, and iteration. Second draft of the project report with oral presentation. (2 units)

### 196. Senior Design Project III

Completion of design and construction of the project, system or device. Design process concludes with formal communication of project details and specifications. Final project report and formal presentation of results. (2 units)

### 199. Directed Research/Reading

Investigation of an approved engineering problem and preparation of a suitable project report. Conferences with faculty advisor are required. Prerequisite: Instructor permission required. (1–6 units)

1. [↑](#footnote-ref-0)