

**College of Engineering
UC Berkeley**

Proposal

**National Academy of Engineering
Grand Challenges Scholars Program**



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Grand Challenges Scholars Program at UC Berkeley

Vision, Mission and Goals

The broad vision of the University of California is to serve society as a center of higher learning, providing long-term societal benefits through transmitting advanced knowledge, discovering new knowledge, and functioning as an active working repository of organized knowledge. UC Berkeley's motto is 'Let there be light.' UC Berkeley strives to be an inclusive campus that educates the whole person in order to create students who can serve as agents of positive change for humankind and our planet. Students who attend UC Berkeley are often drawn to our campus not only for our academic excellence but also our longstanding commitment to social justice. Berkeley students are passionate about conserving our planet and tackling ongoing societal challenges that confront humanity.

The National Academy of Engineering (NAE) has identified 14 grand challenges broadly defined across four themes: sustainability, health, security and joy of living. These societal challenges are multifactorial in nature and require solutions that require not only fundamental engineering principles but also cultural, political, social, ethical and economic awareness.

Sustainability:

- (1) Make solar energy economical
- (2) Provide energy from fusion
- (3) Develop carbon sequestration methods
- (4) Manage the nitrogen cycle
- (5) Provide access to clean water

Health:

- (6) Advance health informatics
- (7) Engineer better medicines
- (8) Reverse-engineer the brain

Security:

- (9) Prevent nuclear terror
- (10) Secure cyberspace
- (11) Restore and improve urban infrastructure

Joy of Living:

- (12) Enhance virtual reality
- (13) Advance personalized learning
- (14) Engineer the tools of scientific discovery

The NAE societal grand challenges require a new generation of problem-solvers who create new capabilities, provide pragmatic solutions for basic human needs, develop new entrepreneurial opportunities, reinvent human interactions, transform systems thinking and connect technology with society. The next generation of engineers must interact with non-engineering partners in order to design and implement context-sensitive solutions. These contemporary problem-solvers need to be mindful of unintended consequences in order to successfully create a sustainable society. These ambitious goals are fully aligned with the vision of the College of Engineering at Berkeley and the mission of the Berkeley campus.

The College of Engineering offers a highly interdisciplinary and societally-minded education. The broad mission of Berkeley Engineering is to educate leaders, create knowledge and serve society. Our engineering program prepares students for leadership and innovation; enhances knowledge through original research and discovery; and serves society with technology and educational outreach. Berkeley engineers who

complete the Grand Challenges Scholars Program (GCSP) will serve as global ambassadors with the requisite skills needed to innovate technologies that enhance well-being, security, health and sustainable energy for society.

Berkeley Engineering comprises 3750 undergraduates spanning Bioengineering, Civil & Environmental Engineering, Electrical Engineering & Computer Sciences, Engineering Science, Industrial Engineering & Operations Research, Materials Science and Engineering, Mechanical Engineering and Nuclear Engineering. There are more than 70 engineering student organizations and competition teams that can be utilized to enrich the learning experience of our undergraduates. Berkeley Engineering offers a plethora of mentored research opportunities within the college, across the campus and abroad. The undergraduate experience at Berkeley guarantees that our students graduate with technical competency. Our engineering programs require not only a rigorous technical path of study rich in mathematics, physics, science and technology but also discovery experiences ranging from required capstones, laboratory explorations, maker labs, and opportunities for critical thinking. Matriculation in our engineering programs assures student readiness to complete their talent competency requirements for the as NAE GCSP as described below.

Berkeley Engineering encompasses several institutes, centers and affiliative programs that provide a robust platform for students to have entrepreneurship and business competency (SCET, MET); multicultural competency (GLOBE, EAP, Blum); multidisciplinary competency (Jacobs, MET, Blum); and social consciousness competency (Blum, Fung, LHS, ES²).

Engineering Student Services (ESS) operates as a welcoming center for Berkeley Engineering students and provides undergraduate advising, degree checks, academic support, counseling as well as career development for undergraduates (engineering.berkeley.edu). ESS is home to the **Center for Access to Engineering Excellence (CAEE)**, which serves as a hub for student engagement and academic success. CAEE offers drop-in tutoring for core and upper division engineering coursework, review sessions, study groups as well as professional skill-building workshops. ESS also offers wellness activities and professional development workshops throughout the year.

ESS provides the framework for a number of specialized programs for engineering students. The Pre-Engineering Program (**PREP**) gives incoming first-year students and junior-transfers (**T-PREP**) a jumpstart on their engineering studies through an intensive three-week summer experience prior to matriculation at Berkeley. These programs target diverse and traditionally under-represented students to assure their success in engineering.

Students who wish to enroll in the GCSP will be introduced to NAE Grand Challenges in our one-unit course entitled *Engin 1: Engineering your Life: Skills for Leadership, Discovery and Service*. This course serves as the entry point into the Grand Challenges Scholars Program (**GCSP**) and provides engineering students with fundamental skills requisite for personal leadership, teamwork, discovery and service. Two sections are offered annually: one for freshmen/sophomores and another for juniors/seniors.

Engineering students can apply to our annual offering of the **LeaderShape Institute** (leadershape.org). The institute runs annually during winter break and provides an immersive leadership program that fosters collaboration, team-building, and ethical considerations for global impact. Costs for these immersive programs are covered through the generous donations from the Berkeley Engineering Annual Fund, GM, Boeing, and RE CARE.

The **Engineering Scholars** as Engaged Scholars (**ES²**) program provides incoming freshmen and transfer students with opportunities to combine engineering innovation with their commitment to social justice for underserved communities. Students who participate in the one-year **ES²** program gain an understanding of cultural dynamics that shape the globalized economy and fulfill their American Cultures requirement by taking *Engin 157AC: Engineering, The Environment, and Society*.

The **Blum Center for Developing Economies** (blumcenter.berkeley.edu) provides a foundation for societal service to address the grand challenge of global poverty. The **Blum Center** provides a unique

framework of courses, interdisciplinary research and global experiences centered upon improving the quality of life for developing countries and people living in poverty. Students can choose from an evolving cohort of courses in Global Poverty and Practice. Sample courses include *GPP 115: Global Poverty: Challenges and Hopes* and *GPP 105: The Ethics, Methods, and Pragmatics of Global Practice*. Students can also opt for a minor in Global Poverty and Practice. Central to the minor is a 6-week fieldwork opportunity termed the Practice Experience in which students connect theory to action through partnership with community organizations, government agencies or other development programs. This can be done domestically or abroad. Funding is available through competitive fellowships.

The Fung Institute (funginstitute.berkeley.edu) offers two-year undergraduate fellowships for Wellness and Technology Innovation. These fellows merge engineering and public health to bring health and wellness to society. Fellows take a year-long two semester sequence *Pb Hlth 196: Special Topics in Public Health*; participate in a summer internship, and partner with industry or community partners to bring ideation to product. Fung Fellows participate in a series of workshops that foster leadership, communication and critical thinking.

The Dado and Maria Banatao Center for Global Learning and Outreach from Berkeley Engineering (GLOBE) develops mutually beneficial educational and research programs with international partners (globe.berkeley.edu). GLOBE offers international internships as well as courses such as *Engin 187: The Global Engineer: The Challenges of Globalization and Disruptive Innovation* that captures requisite skills to become a multicultural engineer.

The Education Abroad Program (EAP) offers students the opportunity for cultural breadth and enables students to take courses at foreign institutions (<http://studyabroad.berkeley.edu>). Students can elect to study abroad for a single semester, a full academic year or a summer session.

The Jacobs Institute for Design Innovation (Jacobs) is UC Berkeley's interdisciplinary hub for learning and making at the intersection of design and technological innovation (jacobsinstitute.berkeley.edu). The Jacobs Institute brings together technical depth, design methodology, and a focus on societal impact. Jacobs brings together students from different disciplines and expertise levels, and offers a range of opportunities for hands-on, team-based learning. Jacobs offers an expansive number of courses targeting the intersection of design, engineering and business innovation including *Des Inv 15: Design Methodology*, *Des Inv 22: Prototyping and Fabrication*, *Des Inv: 181 Reimagining Mobility*, and *IntegBi C 32: Bio-Inspired Design*.

The Lawrence Hall of Science (LHS) is the campus-affiliated science museum that focuses on science education. Interactive exhibits provide experiential learning opportunities for the public sector. LHS educational initiatives and curricula development facilitate outreach to the k-12 sector across the country. Through long-standing collaborations with Berkeley faculty and students, LHS provides project-based engineering design challenges, environmental science programs and summer camps. Many of these programs target schools with underrepresented backgrounds (lawrencehallofscience.org).

The Management, Entrepreneurship, & Technology (MET) program aims to educate leaders with a seamless understanding of technology innovation from inception of idea to impact in the world. Undergraduates in this program earn bachelor of science degrees in both engineering and business (met.berkeley.edu).

The Sutarja Center for Entrepreneurship and Technology (SCET) provides a rigorous program comprising a series of lectures and courses in both entrepreneurship and technology commercialization. Students have the opportunity to invent products and launch start-up companies. Students can enroll in an expansive number of courses that focus on entrepreneurship and innovation (scet.berkeley.edu).

Elements of the GCSP

Scholar Recruitment and Selection

Students may apply to the **Grand Challenges Scholars Program (GCSP)** as early as their first year of study. All students are expected to commit a *minimum of two years* in the program to ensure proficiency and across the five required competencies of the GCSP. Applications will be accepted during both the fall semester (October 15) and spring semester (March 15) of the academic year. Students submit applications through a portal that will be hosted on the COE website (engineering.berkeley.edu). Each applicant will identify the NAE Grand Challenge theme that they plan to study. As part of the application students will specify the elements that they will utilize in order to achieve the five competencies requisite for the GCSP (Table 1). The student application will be completed through a portal for the GCSP program and the portal will also allow students to create a portfolio that will be utilized to monitor student progress in the program. Students will be prompted to specify their Grand Challenge theme and describe why this area is of interest to them (250 words or less). Students will then be prompted to select the elements that they will utilize to satisfy each core competency (Table 2). Element options will be equivalent to a semester or summer of course study.

Table 1. Student Application. The GCSP portal will be located on the COE Website (engineering.berkeley.edu)

Student Name (SID)	Text box for name and SID
Year of Study	Drop down menu – freshman, sophomore, junior, junior transfer
Grand Challenge Theme	Drop down menu – students select GC theme or specific challenge
Describe why you would like to work on this grand challenge (250 words or less)	Text box prompt (250 word limit)
Select proposed elements for fulfilling the core competencies	Drop down menu – students select element(s) that satisfy each core competency - students select minimum elements requisite to satisfy each competency (Table 2)

Recruitment of students into the GCSP will begin at the Golden Bear Orientation for all incoming freshmen and junior transfers. To attract a diverse cohort of scholars we will also recruit for GCSP through the summer bridge programs that target incoming freshmen (PREP) and junior transfers (T-PREP) from underserved populations.

All students enrolled in the GCSP will take both *Engin 1* and *Engin 185* – these courses will bookend the scholar experience. *Engin 1: Engineering your Life: Skills for Leadership, Discovery and Service* introduces the NAE Grand challenges and provides requisite skills for personal leadership, teamwork, communication, discovery and societal service. The course targets freshmen and junior transfers; though all students entering into the GCSP will be able to enroll in the course. *Engin 185: The Art of STEM Communication* is an upper division course that enables students to formally communicate and reflect upon their NAE Grand Challenge discovery experience. Students in this course will write a formal paper that reflects on their GCSP discovery experience. Culminating papers will be published in the Berkeley Engineering magazine.

The goal of the GCSP at Berkeley is to initially select a diverse cohort of approximately 20 students. The longer-term vision is to grow the number of participants to 10% of the College. These students will broadly represent the majors within the College of Engineering and College of Chemistry (Chemical Engineering). We envision that our program will eventually extend across the STEM fields of the campus.

Scholar selection will be done by the GCSP Executive Director (ED), the Associate Dean for Students (Faculty Ambassador), Steering Committee and faculty mentors of the GCSP. Faculty mentors will be given an in-depth orientation into the program, and how it operates at UC Berkeley, including but not limited to

our objectives, the scope of the Berkeley program, and best practices that will aid them in mentoring the scholars. Once accepted into the GCSP, students will submit an annual portfolio that demonstrates committed progress on their grand challenge and associated competencies. Each core competency will require an element that is equivalent to a semester or summer of course study to ensure equivalence across components of the GCSP. These are minimum expectations but students may elect to do more. Each completed competency will require a one-page reflection that is incorporated into the student's portfolio.

Mentorship for individual scholars will be provided by the GCSP ED along with their research mentors. Faculty mentors will participate in annual workshops to share and maintain best practices. Scholars will meet with the GCSP ED each semester to assure that they are progressing successfully in their program. The Berkeley GCSP will facilitate workshops that empower the students to become effective problem-solvers for the societal challenges posed by the NAE. Workshops will also include an enriched emphasis on leadership, ethics, communication and global awareness.

In order to complete the GCSP program and receive the distinction of Grand Challenge Scholar, students will need to submit a completed portfolio to the GCSP ED by April 30 of their graduating year. Scholars will also present their discovery experience as part of a Grand Challenges seminar that will be launched in parallel with NAE GC program.

GCSP Experiences

The aim of the GCSP experience is to enable the scholars to integrate a curricular plan of study that incorporates elements and requisite experiences necessary to tackle a Grand Challenge theme or specific problem. **The Berkeley Engineering GCSP** leverages our engineering curriculum and programs, institutes and centers, as well as diverse discovery experiences supported throughout and beyond our campus. These combined elements ensure that **scholars achieve a rich portfolio centered upon a Grand Challenge** that creates **five core competencies: (1) talent competency, (2) multicultural competency, (3) multidisciplinary competency, (4) business/entrepreneurial competency; and (5) social awareness competency.** Students must demonstrate competency in these 5 areas and maintain a cumulative GPA of 3.0 in order to receive their distinction as a Grand Challenges Scholar (**Table 2**).

Table 2. Core Competencies for NAE Grand Challenges Scholars Program. *Each competency may be completed with an element that is equivalent to a semester or summer course of study.*

(1) Talent competency: Mentored research or project related to a Grand Challenge

Each scholar must complete a Grand Challenge Project that has been approved by the GCSP ED. The mentored project related to a Grand Challenge problem or theme can be in the form of an approved (i) independent research project, (ii) team project or (iii) senior capstone design project. The research must specifically address a societal challenge defined by the National Academy of Engineering. The research experience should be equivalent to a summer or semester-long research experience.

The NAE Grand Challenges are introduced in *E1: Engineering your Life* and students are expected to take this one-unit class in the first year of their GCSP experience. At the culmination of their experience each scholar must submit a completed portfolio and a personal reflection on their discovery experience. Students are expected to complete *E 185 the Art of STEM Communication* in order to build their competency in technical communication.

(2) Multicultural competency: Cultural awareness obtained through global experience

Each scholar must establish cultural awareness. This competency may be achieved in a number of ways including (i) a semester or summer abroad through the education abroad program (EAP); (ii) completion of a GLOBE course such as *Engin 187: The Global Engineer: The Challenges of Globalization and Disruptive Innovation*; (iii) completion of a Blum course such as *GPP 115: Global Poverty: Challenges and Hopes* and *GPP 105: The Ethics, Methods and Pragmatics of Global Practice* or similar multicultural experience through Blum Center; (iv) Participation in a Global Collider experience through SCET; or (v) an internship in another country equivalent to a summer or semester long course of study.

(3) Multidisciplinary competency: Knowledge in technical and non-technical areas

Each scholar must demonstrate proficiency not only in their engineering major but also in a non-technical area. Students can obtain this competency through a number of pathways including (i) an interdisciplinary plan of study which may include courses/experiences that support the Grand Challenge such as those offered through the Jacobs Institute for Design or the Blum Center; (ii) an outside minor in areas that support the Grand Challenge such as Conservation and Resource Studies, Digital Humanities, Public Policy, Psychology, Chemistry etc. or (iii) a simultaneous degree that supports the Grand Challenge.

(4) Viable Business/Entrepreneurship competency: Implementation of technical innovation

Each scholar must express ability to translate innovation into a viable business model for solution implementation or entrepreneurial venture. This competency can be achieved through a variety of experiences including (i) completion of a technical innovation course through the Surturja Center for Entrepreneurial Technology (SCET) or Jacobs Institute for Design; (ii) leadership in an entrepreneurial student club*; (iii) participation in entrepreneurial activities such as the Fung Fellows*; or (iv) a business course offered through the MET program. * Experience must be equivalent to a summer or semester-long course of study.

(5) Social Consciousness Competency: Service for the benefit of society

Each scholar must participate in an experience that creates societal awareness.* This competency can be achieved in a multitude of ways including societal outreach education through (i) active participation at Lawrence Hall of Science (LHS), (ii) an active role in Engineering for Kids (E4K); (iii) active engagement with local k-12 schools through Berkeley Engineers and Mentors (BEAM); or (iv) active work with a national outreach group such as Teach for America, etc. Scholars can alternatively opt to work with global service organizations such as Engineers without Borders, Engineering Projects in Community Service (EPICS) or similar program. Additionally, students can opt to choose a Grand Challenge that specifically addresses a social need such as bringing clean water to developing countries. Students must contribute in a meaningful way through one of societal service activities in order to demonstrate competency. * Experience must be equivalent to a summer or semester-long course of study.

Thematic Continuity and Connectivity

The goal of thematic continuity of the GCSP is to ensure that each scholar intentionally embeds their personally-selected Grand Challenge theme or specific problem across each of the five requisite competencies. An ideal program of study enables students to step into the world and tackle grand challenges confronting humanity and the planet. Berkeley Engineering uniquely leverages a consortium of centers, institutes and programs that naturally lend themselves to alignment with the NAE Grand Challenges and societal service. GC scholars at Berkeley have a multitude of ways to explore their chosen Grand Challenge that meet the criteria of satisfying the five core competencies. The educational goal is to create a global engineer capable of tackling the ongoing challenges for the planet and humanity.

Students will submit a proposed plan of action to achieve the five competencies when they apply to the GCSP. The plethora of available options at our institution offers each scholar a unique way to package their Grand Challenges into a robust portfolio. Students book-end their GCSP experience with *Engin 1: Engineering your Life: Skills for Leadership, Service and Discovery* and culminate with *Engin 185: The Art of STEM Communication* when they formally reflect on their NAE GCSP discovery experience. Each scholar is expected to reflect on ethical considerations, professional responsibility and nonintentional consequences of their research. Mentored research in a GC theme alongside courses, internships or other programs provides each scholar with continuity and synergy amongst the competencies.

Programmatic and Individual Student Assessment

Scholars will submit an annual progress report in the form of an updated portfolio to the GCSP ED. This portfolio summarizes student progress in their chosen Grand Challenge theme and core competencies.

Student progress will be tracked by the GCSP ED. The ED and Steering Committee will review programmatic elements annually to assure alignment with the NAE GCSP. In order to be named a GC scholar, students are required to submit a completed portfolio to the Director of the GCSP by April 30 of their graduating year (or November 30 if a student is graduating in a fall semester). Scholars will present their discovery experience as part of a Grand Challenges Summit Seminar that will be launched in parallel with NAE GC Scholars Program.

Institutional GCSP Governance and Sustainability

The Associate Dean for Students will serve as the Faculty Ambassador for the NAE GCSP and will chair the Steering Committee for the NAE GCSP. The role of the Faculty Ambassador is to assure the academic elements of the NAE GCSP are met. The Associate Dean oversees the academic programs for all engineering students and is well-positioned to coordinate synergistically with the Executive Director of the NAE GCSP to ensure program continuity and competency requirements.

The GCSP at Berkeley will have a Steering Committee that will assess the progress of the program on the whole. The Steering Committee will comprise faculty directors of the associated institutes, centers, programs and affiliated programs. The Steering Committee will provide feedback to the GCSP ED and will assist in oversight of the NAE GCSP.

The GCSP ED along with the Steering Committee will select students and monitor programmatic progress. They will also guide mentorship to the GCSP scholars and approve students who have successfully completed the program. The executive director will annually compile the names and accomplishments of students who have completed the GCSP requirements. The ED will convey this information through an annual report submitted to the Steering Committee and the NAE. To assure success of the GCSP at Berkeley, the ED will attend annual conferences offered through NAE in order to exchange best practices.

Mentorship for GCSP Faculty and Students

The ED and Steering Committee will provide a framework for the mentorship of the scholars. An Annual Grand Challenges Summit seminar will be developed at Berkeley to share best practices and outcomes with NAE GCSP. Students completing the program will present their findings in a completed portfolio as well as in a final NAE GC Scholars Program Seminar. Mentoring workshops will be offered throughout the year to provide a framework for best practices, ethics, leadership and communication.

Student Recognition

Students who complete the GCSP will receive a receive a Grand Challenges Scholar letter from the President of the National Academy of Engineering and will be included in the annual NAE Grand Challenges Scholar press release and web listing of all scholars. Berkeley Engineering will also recognize these scholars on its website and will provide a certificate of completion. Students who complete the GCSP will be asked to submit an article to the annual spring edition of the College magazine *Berkeley Engineer*.

GCSP Personnel

GCSP Executive Director: Kedrick Perry, Ed.D.

Associate Dean for Students (Faculty Ambassador): Professor Lisa Pruitt, Ph.D.

Steering Committee: Associate Dean for Students (Lisa Pruitt), Director of the Fung Leadership Institute (Lee Fleming); Director of Jacobs Design Institute (Bjoern Hartmann); Director of SCET (Ikhlaq Sidhu); Director of Blum (Shankar Sastry); Director of GLOBE (Matt Sherburne); Director of ESS Advising and Policy (Sharon Mueller); Director of ESS Student Programs (Marvin Lopez); and Director of LHS (Rena Dorph).

Funding

Funding will be provided by the College of Engineering for GCSP Website development that includes a portal for student applications and portfolio development. COE will provide funding for the executive director, training workshops and annual travel to NAE GCSP conferences. We anticipate industry sponsorship for scholars, workshops, research experiences, internships and scholar travel as our program evolves.