

Proposal to Establish a Grand Challenges Scholars Program (GCSP)
at New York University - Abu Dhabi (NYUAD)

Submitted to

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1. Introduction

The National Academy of Engineering (NAE) has identified 14 Grand Challenges for Engineering and called for a new engineering education paradigm – the Grand Challenges Scholars Program (GCSP) – to prepare engineers to address those challenges and help change the world. The GCSP has been implemented at engineering schools around the world, with more schools planning to join this initiative. New York University in Abu Dhabi (NYUAD) wishes to become a member and an active participant in this global effort on the part of engineering schools and industry to address some of the most crucial issues of our time and to prepare students to find innovative solutions to the challenging problems facing humanity as exemplified by the Grand Challenges.

1.1. NYUAD Engineering and GCSP: A Natural Fit

Consonant with the NAE’s Vision for Engineering in the current century, “Continuation of life on the planet, making our world more sustainable, safe, healthy, and joyful,” the GCSP is envisioned as a combined curricular, co-curricular, and extracurricular program with five competencies especially designed to prepare students to address major global challenges facing society in this century. The five competencies are:

1. Research/Creativity: Mentored research or project experience to enhance technical competence
2. Multidisciplinarity: Understanding of the multidisciplinary character of implementable solutions
3. Business/Entrepreneurship: Understanding that viable business models are necessary for successful implementation
4. Global/Multicultural: Understanding that serious consideration of cultural issues is mandatory for all viable solutions
5. Social Consciousness: Motivation to address societal problems, often gained through service learning, because serving people and the planet is the vision served by the Grand Challenges

The mission of the NYUAD Engineering Division is to educate and shape leaders in engineering, technology, and innovation for the modern, technologically advanced, competitive global society. To fulfill this mission the Engineering Curriculum has incorporated the following highlighted features:

- a. Engineering curricular depth built on the foundations of a multidisciplinary liberal arts core; the blurring of boundaries between engineering traditional disciplines, and curricular integration across science and engineering
- b. Emphasis of innovation, invention, and entrepreneurship through curricular requirements, as well as available via extra-curricular activities and on-campus programs / resources
- c. Required semester-long study away in New York or Shanghai campuses, and up to two January terms abroad

- d. Co-curricular “Engineers for Social Impact (EfSI)” activity required for first year engineering students, and optional follow-on EfSI project opportunities for upperclassmen
- e. Summer research opportunities on campus, and resources for summer internships available to all continuing students

We believe the breadth and features of the NYUAD engineering education have significant overlap with, and will complement, the GCSP and support its implementation at NYUAD.

1.2. About NYUAD

New York University's (NYU) agreement with the Emirate of Abu Dhabi to create NYU Abu Dhabi (NYUAD) is the outcome of a shared understanding of the essential roles and challenges of higher education in the 21st century: a common belief in the value of a liberal arts education, concurrence on the benefits a research university brings to the society that sustains it, a conviction that interaction with new ideas and people who are different is valuable and necessary, and a commitment to educating students who are true citizens of the world. NYU Abu Dhabi welcomed its inaugural class in 2010.

As the first comprehensive liberal arts and science campus in the Middle East operated abroad by a major American research university, NYU Abu Dhabi has been built on the following principles:

- NYU Abu Dhabi is a research university with a fully integrated liberal arts and science college, including ABET accredited engineering programs. It draws students from around the world, and prepares them for the challenges and opportunities of our interconnected world.
- NYU Abu Dhabi equips students for leadership in all arenas of human endeavor. It fosters curiosity, creativity, and critical reflection. At NYUAD, students extend themselves and the frontiers of knowledge.
- The residential life of students is central to the University's academic mission. Learning takes place across the campus, not only in classrooms, but also in residential houses, through participation in clubs and sports, during informal campus gatherings, and being engaged with the wider community (including the resident student body from over 80 countries at any given time).
- NYU Abu Dhabi stimulates advanced research. The NYUAD Research Institute is a major research center. Research is integral to the undergraduate experience at NYU Abu Dhabi, and it also drives the University's nascent graduate programs on the Abu Dhabi campus.
- NYU Abu Dhabi, NYU New York, and NYU Shanghai form the backbone of a fully connected global network. As one of the three major hubs in the global network,

NYUAD creates a unique capacity for faculty and students to access the assets of the entire university system.

NYU Abu Dhabi aspires to be a great research university, with an exceptional liberal arts and sciences college at its core. A diverse and vital center of distinctive education and scholarship, actively embedded in NYU's global network, it aims to be recognized as the model for a new paradigm in higher education: the university as an engine of a more peaceful, cooperative, and productive world. NYUAD as an institution is rooted in Abu Dhabi, a leading global city that is open and dynamic, economically and culturally vibrant, and a magnet for diverse and creative people from across the UAE and around the world.

NYU Abu Dhabi is pioneering a new model of higher education for a global world, dedicated at once to excellence in teaching and research and to advancing cooperation and progress on humanity's shared challenges. Drawing on the strengths of the NYU global network, it offers an outstanding liberal arts and sciences education to students from the region and around the world, with a distinctive focus on intercultural understanding and leadership. It supports innovative research and graduate education programs that push forward the frontiers of knowledge and respond in powerful and interdisciplinary ways to vital global and local challenges. In addition, NYUAD advances NYU as a model global university for the 21st century.

1.3. About Engineering at New York University

The New York University Tandon School of Engineering was founded in 1854 in Brooklyn, New York, as the Brooklyn Collegiate and Polytechnic Institute, best known as Brooklyn Poly. In 2014 an official merger was completed with NYU — a momentous event that brought the discipline of engineering back to the university for the first time since the closing of NYU's iconic University Heights campus, home to the School of Engineering and Science, four decades earlier. The following year, in 2015, thanks to a transformative gift, the school was renamed the NYU Tandon School of Engineering. Throughout its history, in New York and now in Abu Dhabi, the promise has always remained the same: to harness the power of science and technology for the sake of a better society.

1.4. About Engineering at NYUAD

The Engineering Division and its programs at NYUAD, while fully autonomous, work in close collaboration with the NYU Tandon School of Engineering in Brooklyn, New York. NYUAD engineering students typically spend one or two semesters taking courses at Tandon which supplement and enrich the NYUAD program and expand the field of opportunities and types of experiences available to NYUAD students.

The NYUAD Engineering Division believes that “The challenges of engineering for the 21st century are varied, complex, and cross-disciplinary. Ranging from the nano-scale to mega-projects, they are characterized by sustainability concerns, environmental and

energy constraints, global sourcing, and humanitarian goals. In the face of global competition, dwindling natural resources, and the complexity of societal needs, the leaders of technological enterprises will be those who can innovate, are inventive and entrepreneurial, and understand how technology is integrated within society.” Guided by this vision, the Engineering Division offers academic, co-curricular, and extra-curricular programs that share the same goals and traits of the GCSP.

The research emphasis and teaching focus of the NYUAD Division of Engineering is fully in the spirit of the National Academy of Engineering’s Grand Challenges Scholars Program. A distinguished and diverse engineering faculty at NYU Abu Dhabi engages in state-of-the-art research, innovation, invention, and entrepreneurship. Faculty research is centered around five thematic areas:

- Cyber Security
- Robotics
- Urban Systems
- Environmental Sustainability
- Biomedical and Health Systems

These five thematic areas map to elements of NAE’s Engineering Grand Challenges, especially within Secure Cyberspace, Enhance Virtual Reality, Restore and Improve Urban Infrastructure, Provide Access to Clean Water, Develop Carbon Sequestration Methods, Advance Healthcare Informatics, and Engineer the Tools of Scientific Discovery.

The undergraduate majors and degrees offered by the Division are listed below.

Table 1: Majors and Degrees offered by NYUAD

PROGRAM	DEGREE	MAJOR
Civil Engineering	BS	Major
Computer Engineering	BS	Major
Electrical Engineering	BS	Major
General Engineering	BS	Major
Mechanical Engineering	BS	Major

2. The Proposed GCSP within NYUAD Engineering Programs

2.1. The NYUAD GCSP Goal

The goal of the **Grand Challenge Scholars Program at NYUAD** is to *provide NYUAD engineering students with a learning experience that has been internationally recognized and established as addressing engineering global grand challenges, namely, the Grand Challenges Scholar Program (GCSP) of the National Academy of Engineering (NAE) of the United States of America.*

2.2. NYUAD and GCSP alignment

The following table shows the alignment that exists between NYUAD Engineering program attributes and the competencies of the GCSP. The correlations are described in detail below and in appendices.

Table 2. Mapping NYUAD Attributes to GCSP Competencies

GCSP Competencies (1.-5.) →	1. Research / Creativity	2. Multidisciplinary	3. Business / Entrepreneurship	4. Global / Multicultural	5. Social Consciousness
NYUAD Attributes (a.-e.) ↓					
a. Interdisciplinary Curriculum (incl. Capstone) / Liberal Core	X	X		X	X
b. Innovation, Invention, Entrepreneurship	X	X	X		
c. International / Study Away	X	X		X	X
d. Engineers for Social Impact / Service Learning		X	X	X	X
e. Summer Research / Internships	X		X	X	

The attributes of NYUAD are briefly summarized below. These are either required curricular or co-curricular elements, or are programs and resources available on campus for interested students.

a. **Interdisciplinary Curriculum.** The engineering curriculum requires a minimum of 140 credits that includes required depth in disciplinary subjects as well as breadth for exploration and enrichment. The distribution is as follows:

- The liberal arts foundation (44 credits) – Liberal Core (24 credits), First Year Writing Seminar (4 credits), General Free Electives (16 credits). For example, several courses that explore the GSCP themes from an interdisciplinary approach are already available.
- Math and Science (minimum 34 credits) – required Foundations of Science integrated sequence (18 credits), required Mathematics (16 credits).
- Engineering (minimum 56 credits) – interdisciplinary Engineering Common Courses (17 credits), disciplinary required and interdisciplinary engineering electives (39 credits). Each engineering program takes a very interdisciplinary approach in developing and offering courses in their respective curriculum, and the senior capstone is an important culminating experience.

The remainder of the credits (at least 6 credits) can be devoted to electives from across the disciplines available at the University. As seen from the above, the NYUAD engineering curriculum emphasizes and encourages a multidisciplinary and holistic approach to engineering knowledge and skills acquisition, without compromising the disciplinary depth essential for successful engineering practice. Please see *Appendix 1* for more details about the engineering curriculum, *Appendix 2* for the capstone, and *Appendix 3* for the university’s multi- and inter-disciplinary approach.

b. **Innovation, Invention, and Entrepreneurship.** The engineering programs introduce the concepts and practice of innovation and invention very early in the curriculum. The freshman Design and Innovation class is a required immersive class during the January term of the first year. It uses the extensive resources of the IDEALab Design Studio, a 24X7 4,000 sq. ft. state-of-the-art facility that allows students to design, innovate and prototype their ideas. NYUAD also offers a well-established program called startAD to students and the wider community (<https://sites.nyuad.nyu.edu/nyuadstartad/>) that includes regularly scheduled courses and workshops to develop entrepreneurial thinking and to develop the skills needed to turn innovative concepts into realistic business plans. Students are also encouraged and supported to participate in regional and international business plan competitions. Support for patenting is also provided. Please see *Appendix 4* for discussion of innovation and invention, and *Appendix 5* for entrepreneurship and business programs.

c. **International study-away experiences and study-away semester.** Every engineering student at NYUAD spends at least one semester studying away in New York or Shanghai.

This is built into the structure of the program where the semester in New York is in Junior Spring and Shanghai in Sophomore Fall. All students are also encouraged to study abroad up to two January terms. Please see *Appendix 6* for more details.

d. **Service Learning.** The engineering division runs the Engineers for Social Impact (EfSI) co-curricular program where first year students are required to participate in a week-long immersive experience during the Spring break. Student groups live within a community and participate in community based projects such as building houses with Habitat for Humanity NGO. In the subsequent years, EfSI projects tackle student-identified projects in communities across the globe. These second year EfSI projects are optional and can be done by students in sophomore, junior, or senior years. Please see *Appendix 7* for more details.

e. **Summer Research / Internships.** NYUAD runs a summer research program for its students where students participate in faculty research labs and research groups for up to eight weeks. Competitive grants for pursuing external research or internship are also available by application. Students are also encouraged to seek paid internships in industry. So far, every engineering student who has graduated from NYUAD has had at least one summer research or internship experience. More details are also presented in *Appendix 6*.

Table 3. How to satisfy NYUAD GCSP Requirements

GCSP Competency	How to satisfy Requirement at NYUAD
Competency 1 Research / Creativity	<ul style="list-style-type: none"> • Design and Innovation Course <i>AND</i> • 2 semester Senior Capstone Team Design Project on a topic related to a GC theme chosen by the student <i>OR</i> An approved summer research project related to chosen GC theme <i>OR</i> A second year EfSI project related to GC theme.
Competency 2 Multidisciplinarity	<ul style="list-style-type: none"> • Year 1- GCSP Introductory Workshop with the goals of becoming aware of the program, the grand challenges. <i>AND</i> • Years 2-4: Take at least 1 non-engineering elective course aligned with the chosen GC theme.
Competency 3 Business / Entrepreneurship	<ul style="list-style-type: none"> • Register for and complete a business / entrepreneurship activity of the NYUAD startAD program.

GCSP Competency	How to satisfy Requirement at NYUAD
	<p style="text-align: center;"><i>AND</i></p> <ul style="list-style-type: none"> • Secure an internship or other research/project experience that explicitly involves innovation, invention or related activity <i>OR</i> Participate in an approved local, regional or international Business Plan Competition.
<p>Competency 4 Global / Multicultural</p>	<ul style="list-style-type: none"> • Spend a one semester studying away and have a cultural experience in addition to technical courses. <p style="text-align: center;"><i>AND</i></p> <ul style="list-style-type: none"> • Participate in an NYUAD international J-term <i>OR</i> Participate in an international Summer School in a foreign university <i>OR</i> Take an approved free elective that addresses global / multicultural topics.
<p>Competency 5 Social Consciousness</p>	<ul style="list-style-type: none"> • Participate in the Engineers for Social Impact EfSI co-curricular activity <p style="text-align: center;"><i>AND</i></p> <ul style="list-style-type: none"> • Participate in at least one Service Learning Activity through the Office of Community Outreach (OCO)

2.3. GCS Program Elements:

a. Outreach and Awareness:

The GCSP will be described on the NYUAD website, and in all printed and online admissions materials. Admissions counselors will be familiar with the program and able to answer questions. NYUAD’s first-year mentors, as well as all engineering faculty members, will be familiar with the program and will build awareness within the enrolled student community. During the freshman orientation the program will be introduced and students encouraged to apply. Examples of GCSP projects will be made available to prospective participants by the GSCP Director.

b. Selection Process:

Participation in the GCSP will be open to all NYUAD students enrolled in any of the previously listed engineering programs. As seen in the Appendices, the NYUAD academic curriculum and rich menu of co-curricular opportunities already incorporates experiences that include the development of *leadership strengths, project based learning and service learning*, as well as addressing the grand challenges of engineering problems. Therefore,

by design, all students in any of the NYUAD Engineering programs are candidates to participate in the GCSP. Students from other programs in the future may be able to apply if their academic program includes the essential courses and their application is approved by the Academic Dean of their Division. There will be no enrollment cap, and the Engineering Division will encourage all its students to enroll.

Appendix 8 shows the Application form for students. Students accepted in the program will work under the mentorship of the GCSP Director or an assigned faculty GCSP Mentor. Usually the GC student will indicate his/her preference of faculty member(s) to be the Mentor, and GCSP Director will take that into account in assigning the role for the student. An NYUAD GCSP faculty admissions committee will meet at the beginning of each semester to evaluate student applications. Students may submit an application for admission into the program until the beginning of Junior year.

For freshman applicants the selection will be based on the essay submitted by the student. The GCSP Faculty Committee will evaluate the student's interest and sincerity in the application essay and will interview any student whose commitment to the program seems uncertain. In addition to the essay, the academic record of students who apply after their freshman year will also be evaluated. The academic advisor will also be asked to submit a recommendation letter for post-freshmen applicants.

c. GCSP Themes/Topics: The school is focusing on the following research themes which are aligned with selected GC themes/topics, as shown.

NYUAD research themes:

- Cyber Security
- Robotics
- Urban Systems
- Environmental Sustainability
- Biomedical and Health Systems

For the GC program, NYUAD will initially focus on the following GC themes:

Energy and Environment Grand Challenge Theme:

- (1) Make solar energy economical (maps to NYUAD Environmental Sustainability)
- (2) Provide access to clean water (maps to NYUAD Environmental Sustainability)

Health Grand Challenge Theme:

- (3) Advance health informatics (maps to NYUAD Biomedical and Health Systems)
- (4) Reverse engineer the brain (maps to NYUAD Biomedical and Health Systems)

Security Grand Challenge Theme:

- (5) Secure cyberspace (maps to NYUAD Cyber Security)

(6) Restore urban infrastructure (maps to NYUAD Cyber Security and Urban Systems)

Joy of Living Grand Challenge Theme:

(7) Enhance virtual reality (maps to NYUAD Robotics)

(8) Engineer the tools of scientific discovery (maps to NYUAD Biomedical and Health Systems)

d. GCSP Workshop:

All aspiring and/or accepted GCSP Scholars will be required to register for and attend a zero-credit GCSP Workshop/Course. In this course the various grand challenges facing society will be discussed, and the identification and approaches advocated by NAE and other world and regional bodies will be reviewed. Students will have a chance to present their own thoughts regarding the challenges and deliberate on the merits of their choices.

e. GCSP Mentoring and Student Assessment:

The GCSP aligns well with the core education and engineering degree programs at NYUAD such that all engineering students are invited to participate in the GCSP. Successful completion of the requirements and stages of the program will be marked in the student record where their progress toward completion of the certificate will be duly maintained.

GC Scholars will be able to indicate their preference of faculty member(s) to be the GCSP mentor, and GCSP Director will take that into consideration in assigning the faculty mentor. The mentor, along with the Director, will advise the scholars on the integration of GCSP projects with their academic and extra-curricular activities, the selection of courses, research/project topics, and generally how to fulfill the requirements of the five components to address their particular Grand Challenge. The mentor will also be responsible for evaluating the Student Scholars' overall performance and qualification for the GCSP Certificate. See *Appendix 9* for the Assessment Forms.

The assessment numbers (1 – 5) in the Assessment Forms indicate degrees of excellence with 5 being the highest:

- 5 = Exceptional, truly outstanding (for a regular course the grade of A),
- 4 = Excellent (grade of A-),
- 3 = Very good (B+, B, B-),
- 2 = Acceptable, but not what is expected from GCSP students (C+, C),
- 1 = Completed but below average and not acceptable for GCSP (below C).

For non-course GCSP activities the assessments will be made by the relevant supervising faculty member who will provide, in addition to the score as indicated above, a description of the work done and notable accomplishments, originality, care, work-ethic, etc., as appropriate. For activities such as service projects that are not directly supervised

by faculty members, the scholars will submit a report that will be assessed by the GCSP Director.

The average of the assessments for the five competencies must be 3 or above and no 1 is permitted to be included in the average. Students whose work is less than excellent (4) will be given the opportunity to revise and improve their assessment.

Students must stay on track, and be able to complete all requirements by graduation. GCSP students will need to include a statement explaining how their selected capstone/senior design project relates to the Grand Challenges. Also, students whose overall GPA is below B will be interviewed and work evaluated by GCSP Faculty Committee who must approve their continuation in the program.

f. GCSP Additional Programming:

An end-of-the-year gathering will be held for all GCSP scholars where the graduating seniors will present their capstones and other GC projects. In addition, there will be a gathering of all GCSP students once a semester where an external speaker will be invited to present perspectives and projects related to GC themes. This gathering every semester will also serve as a social event where pizza will be served, and students will get a chance to interact with their GC peers. These activities will serve to build a community of GC scholars on campus.

NYUAD will also support the travel of a faculty member and select students to attend the GCSP annual meeting.

From time to time, NYUAD may also arrange field visits related to GC topics, as appropriate.

g. GCSP Official Records and Certificate:

A record of all NYUAD GCSP student progress will be maintained by the GCSP Director. As each component requirement of the program is completed, it will be entered into this record. It will be the responsibility of the student to report the successful completion of a requirement to the Director to ensure that it is entered into the record.

All students who successfully complete all requirements for the NYUAD GCSP will be awarded a *certificate* by the University. The awarding of this certificate will become part of the student's *permanent record* and noted on all *official transcripts*.

h. GCSP Organization and Administration:

The GCSP will be led by a Director who reports to the Dean of the Engineering Division. The Director will administer, oversee and assess the GCSP. A full-time regular member of the NYUAD Engineering faculty will serve as Director and be fully responsible for this. The requirements for the GC Director include:

1. Excellent organization and communication skills. The various activities under the five components of GCSP to address the selected NYUAD Grand Challenges requires extensive organization, management and communication to guarantee the program running smoothly.
2. Interdisciplinary experience and interests, so that the Director can oversee the design of the program and ensure the comprehensive coverage of the GCSP.

Dr. Sunil Kumar will serve as the inaugural NYUAD GCSP Director. See *Appendix 10* for the Director's CV.

The GCSP Director will conduct the mandatory GCSP Workshop.

A GCSP Faculty Committee will be formed to evaluate the applications for admissions and to assist the assessment of continuing GC scholars.

As seen above, the faculty research areas are related to the Grand Challenges topics. Chosen engineering faculty GCSP Mentors will help to link individual GC Scholars with research opportunities within their programs or within interdisciplinary groups, and help to advise Scholars on course selection and on how to complete the five components of the GCSP program.

i. Resource Plan

Financial support for the operation of the GCSP at NYUAD will be included in the budget of the Engineering Division and other operational budgets as appropriate. See *Appendix 11*.

Special financial support will be added for specific GCSP related activities, including the costs for GCSP lectures, research, travels and other approved program costs not covered by previously budgetary resources. Financial support to attend the annual GCSP meeting will also be budgeted.

The GCSP at NYUAD will leverage other resources wherever possible through collaboration with local and international programs that address aspects of the Grand Challenges.

j. NYUAD GCSP Advisory Committee

The leadership of the NYUAD GCSP will consult with Members of the Advisory Committee about all aspects of the program and will solicit suggestions and expertise, as well as share experiences. The Advisory Committee will also facilitate networking between the program at NYUAD and industry, NGO's, and other institutions concerning suitable projects and outreach for GCSP students. The Committee membership will include individuals from both academic and non-academic organizations and from the UAE and the United States. Individuals will be invited to join the Advisory Committee by the NYUAD GCSP Director. The Committee will elect its own Chair. See *Appendix 12*.

List of Appendices

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Appendix 1 –

NYUAD Engineering Curriculum Description

Engineering challenges of the 21st century are varied, complex, and cross-disciplinary. Ranging from the nano-scale to mega-projects, they are characterized by sustainability concerns, environmental and energy constraints, global sourcing, and humanitarian goals. In the face of global competition, dwindling natural resources, and the complexity of societal needs, the leaders of technological enterprises will be those who can innovate, are inventive and entrepreneurial, and understand how technology is integrated within society.

Engineering at NYU Abu Dhabi is designed to create technological leaders with a global perspective, a broad education, and the capacity to think creatively. The uniqueness of the program lies in the integration of invention, innovation, and entrepreneurship (i2e) into all phases of study. Through i2e students enjoy a learning environment conducive to creativity, which is at the heart of tomorrow's technological innovations and enterprises.

NYU Abu Dhabi offers five engineering degree programs: Civil Engineering, Computer Engineering, Electrical Engineering, Mechanical Engineering, and General Engineering. Graduates receive a Bachelor of Science degree. The engineering programs provide a sound preparation for careers in research, academia, industry, or government.

A distinguished and diverse faculty engages in state-of-the-art research, innovation, invention, and entrepreneurship. Their research is concentrated in five thematic areas: Cyber Security; Robotics; Urban Systems; Environmental Sustainability; and Biomedical and Health Systems. Faculty at NYU Abu Dhabi actively collaborate with faculty in other divisions at NYU Abu Dhabi as well as faculty in the departments of Civil, Chemical and Biological, Computer, Electrical, and Mechanical Engineering at NYU Tandon School of Engineering. The Engineering Program draws upon courses across an array of disciplines. The liberal arts core provides the intellectual breadth, a "license to learn," preparing students to thrive in a multicultural globalized world and equipped to learn and adapt quickly in areas that evolve with ever-increasing swiftness. Students gain a firm grounding across various science and engineering fields that underscore the technical component of an engineering education, but they also draw upon courses across the curriculum to develop an understanding of cultural, political, economic, environmental, and public safety considerations that are integral to engineering solutions. In their engineering courses, students are involved in the design process and the progression of technological inventions from concept through product development and market feasibility.

Engineering majors take the four-course sequence *Foundations of Science (FoS)*. This is followed by *Engineering Common Courses*, a series of courses, including a 1-cr Ethics

course. *Engineering Common Courses* explore fundamental engineering topics of importance to all engineering disciplines, including mechanics, conservation laws, computer programming, digital logic, electrical circuits, numerical methods, design and innovation; they expose students to transdisciplinary technological fields that combine several traditional areas of engineering, complementing the in-depth knowledge acquired in an area of specialization. In the Ethics course, students examine the foundations of ethics, the broad scope and complexity of ethical claims, as well as ethical issues specific to engineering and technology and ethics in the profession.

Many of the elective courses are connected to one or more of NYUAD's engineering research areas: Cyber Security; Robotics; Urban Systems; Environmental Sustainability; and Biomedical and Health Systems. Once the Grand Challenges program is underway, the students in the program, in consultation with their academic mentor and the GCSP Director, will be encouraged to consider engineering electives in one of the five research areas with an emphasis on their chosen GC theme. Students may participate in special opportunities for directed study, summer laboratory research, internships, and other co-curricular opportunities related to the themes of the Grand Challenges for Engineering. Upper-level students may become involved in research projects in faculty laboratories and participate in internship and incubator activities, gaining hands-on experience working side by side with faculty or in companies. Numerous research and internship opportunities are available at all stages in the student's academic program, including after graduation. Students will be encouraged to discuss these options with their faculty mentor or the GCSP Director.

Accreditation of the academic programs at NYUAD is briefly discussed in *Appendix 13*.

Appendix 2 –

Description of Capstone / Senior Design Project

The goal of the two-semester Capstone Design Project in the Senior year is to provide students with a major design experience that leverages the knowledge and skills acquired through their undergraduate studies. Its structure includes a process of design with measurable metrics, and incorporation of appropriate engineering standards and multiple realistic constraints, including ethical, societal, and environmental. Emphasis is placed on clearly framing the design problem and following the design process to result in an optimized solution. Students are encouraged to build prototypes of their designs and seek validation of their solutions through simulations and experiments, as appropriate.

The Capstone Project aims to be collaborative and trans-disciplinary across several engineering streams. The emphasis is on students applying the design process to solve real-world problems in a 21st century, global context. The projects address engineering and technology topics that overlap with the sciences, social sciences, or liberal arts. The Capstone provides an opportunity to integrate technical, aesthetic, business, and ethical concerns with engineering design. Students practice critical skills in communication, team-building, and project management. Students complete their design, as well as build and test their prototypes, if applicable, in the spring semester. The senior year project sequence culminates in a comprehensive project report and design review by a committee of faculty and other professionals.

An engineering division faculty member is assigned to be the capstone coordinator for the entire division. This ensures consistency and quality across all projects. Each project team is guided by a faculty mentor. The first semester is usually devoted to background and literature review, as well as analysis and design, while the building and testing of the prototype takes place in the second semester.

Once the Grand Challenges program is underway, the students in the program, in consultation with their academic mentor and the GCSP Director, will be required to consider projects on topics in their chosen GC theme.

The following is an illustrative list of capstone projects from 2017-18 that show the existing links to GC themes.

Select Capstone Projects for the Academic Year 2017-18

- Logic Locking Framework

Students: Hazem Ibrahim and Hamdan Al-Hosani

Related to Security Grand Challenge Theme

IC netlists are valuable assets by nature since they hold the basic designs of electronic chips. However, the process of manufacturing chips is complicated as there are multiple threats from untrusted users and fabricators. Logic Locking has been perceived as a promising and reliable defense mechanism against intellectual property piracy, reverse engineering, and overbuilding attacks. Stripped Functionality Logic Locking, or SFLL, is proven to be resilient to all types of hardware attacks on a netlist. SFLL strips some of the functionality of the circuit and hides it in the form of a secret key(s), thereby rendering the on-chip implementation functionally different than the original netlist. Currently, implementing any logic locking framework on a given netlist is complicated. In this project, a software framework that implements SFLL on any Verilog netlist is developed. The software produces a secured netlist that can thwart multiple attacks such as SAT attack, removal attack, and sanitization attack. In addition, verification of the correct implementation of SFLL security is demonstrated to ensure the validity of the software framework.

- The Multimedia Haptic Learning Device for Children

Students: Farzan Khan, Yara Elwazir

Related to Joy of Living Grand Challenge Theme

Studies have shown that incorporation of a haptic modality expedites the handwriting learning process and improves retention. A prototype of a haptic learning device was developed and experiments conducted on the device showed the effectiveness of the device in teaching non-Arabic speakers how to write Arabic letters. This consisted of a Novint Falcon Device, which manipulated a pen mimicking the movement of a pen over the letters in question. Feedback collected from these experiments pointed to some hardware shortcomings, which led to a user experience which had significant room for improvement. Feedback fit the following three categories: obstruction of line of sight, limited usability to right-handed users, and different planes of operation of the display and pen movement. This capstone project aimed at developing the hardware to develop a ready to use haptic learning device for children. A second generation device was developed and tested.

- Efficient and Lightweight Cryptographic Primitives for Extreme Embedded Systems Environments

Students: Prasant Adhikari, Mounir Elgharbawy and Lucas Futch

Related to Security Grand Challenge Theme

The objective of the project was to evaluate and optimize multiple encryption algorithms using multiple metrics to generate a benchmarkable and balanced

algorithm. Most implementations focus on only optimizing for one evaluation metric, leaving an unbalanced implementation. This project was approached by deciding to observe the trade-offs that occur when using optimization strategies such as loop unrolling or pipelining, and making sure a well-balanced algorithm was achieved with the desired performance. This project explored AES, NORX, TEA, XTEA, and SPARX, and applied permutations of strategies and techniques and analyzing their effect on observable metrics. Different families of encryption algorithms were generated that are applicable to future iterations of hardware encryption.

- High Efficiency Wifi for Next Generation Urban Networks

Students: Ali Abouelatta and Enes Krijestorac

Related to Security Grand Challenge Theme

Due to the improvements made to the wireless standard in the past two decades, wireless has overtaken wired as the dominant form of communication today. To meet the future data traffic needs, the Wi-Fi standard of today will need to be significantly improved in both the quality of service and security. Since the number of Wi-Fi networks in both residential and enterprise urban environments is increasing rapidly, the interference between geographically collocated networks is becoming one of the significant issues of Wi-Fi. This happens because access points of different Wi-Fi networks operate independently. A device located at the overlap of two or more networks may not be able to receive data because access points from various networks are interfering. This is called the hidden terminal problem. Given that the hardware processing capabilities are increasing, in the future, the signal detection threshold of CSMA/CA may become a dynamic value. In this project, we used dynamic CSMA/CA signal detection energy thresholds instead of the currently static one. The signal detection threshold utilizes the signal strength received from the access point to solve the hidden terminal problem more efficiently at the overlap of Wi-Fi networks.

- Automated Fetal Kick-rate Monitoring Belt

Students: Aida Aberra and Siba Siddique

Related to Health Grand Challenge Theme

Monitoring fetal well-being is a crucial procedure in modern obstetrics. Among the many methods of checking fetal well-being, fetal movement detection is widely used to identify changes in fetal activity and reduce the possibility of fetal distress and stillbirth. Standard clinical practice of fetal movement monitoring involves the use of ultrasound which relies on high frequency sound waves to generate an image of the fetus. Doctors also recommend pregnant women to use

fetal kick counting as a way to monitor their baby's health beginning from the third trimester. Fetal movement counting is a method by which pregnant women quantify the movements they feel to assess the condition of their baby. While fetal kick can vary on daily bases, a significant deviation from the normally expected value, which is 10 kicks in 2 hours, indicates that the woman should consult her medical provider. While fetal movement can be observed using ultrasound imaging, a non-invasive and home based monitoring system is still in development to enable pregnant women perform self-administrated monitoring. In this project, an Automated Fetal Kick system is developed by using a matrix of Force Sensitive Resistors (FSRs), and multiplexers. The final product integrates the array of sensors in a maternal belt, and sends information about the number of kicks and the frequency to a cell phone via wireless communication. The system is able to detect a fetal force which found to be 0.52 ± 0.15 N, with more than 90% overall efficiency.

- Xylem based Water Filtration System

Students: Zoha Alvi and Keerthana Prakash

Related to Energy and Environment Grand Challenge Theme

Potable or drinkable water is defined as having acceptable quality in terms of its physical, chemical and bacteriological parameters so that it can be safely used for human consumption. Among the various water pollutants, biological contaminants are the most fatal in developing regions. The most common water pathogens consist of bacteria, viruses and protozoa, and are major contributors to the most common and widespread health risk associated with drinking water. The only possible way to achieve potable water is to carry out disinfection processes. Nano-pores in Gymnosperm plant xylem has been identified as an efficient filter of bacteria due to the "short tracheid that would force water to flow through pit membranes". The availability of this plant in the region makes it an affordable and reliable source to be incorporated in a water filter device. In addition, adding a compartment for sand and charcoal each makes the water filter more efficient at filtering out the physical, chemical and biological contaminants. In this capstone project, we develop an advanced multi-step xylem-based filter that can filter bacteria and heavy metals without blockage problems at an economical cost to people residing in developing regions who do not have access to potable water.

- Solar Air Conditioning

Students: R. Aboulhassan, S. Tampoe, S. Genet and W. Young

Related to Energy and Environment Grand Challenge Theme

The purpose of this capstone project is to design, build and test a single-effect

absorption refrigeration cycle that uses solar energy as the sole source of energy. Design goals are focused on low toxicity, sustainability, reliability and therefore, applicability to urban environments. Conventional vapor compression cycles use electricity and emit gases that cause air pollution and therefore, there is a strong imperative to create an alternative.

- Solar Tube Lighting

Students: Levan Asatiani, Majed Bou Ghanem, Sofia Fernandez Santoyo and Yohana Mpuya

Related to Energy and Environment Grand Challenge Theme

The aim of the developed device is to transport sunlight into indoor spaces using a device that is independent of the grid, not only to preserve energy for the long term but to also provide people with better quality light. The spectral composition of LED's and current indoor lighting technology is not ideal. Before the invention of artificial light technology, the only source of light eyes adapted to is the sun. Natural light stimulates essential biological functions (regulating circadian cycles), improves mood and reduces eyestrain and reduces the risk of Seasonal Affective Disorder. The light collection system developed is a heliostat using a fresnel lens and actuated mechanically in the azimuthal and elevation angles, controlled by feedback from photosensors mounted on the lens. The actuation aims at following the sun in the sky to maximize power transmitted. The power source for actuation is designed to be an external PV panel such that the system is independent of the grid.

- Sustainable Low-income Housing Design

Students: Isaiah C. Mwamba, Hassan A. Mahmoud, Noor E. Alameri and Billy T. Ben

Related to Energy and Environment / Security Grand Challenge Themes

Around the world, formal housing is an increasingly scarce resource, with only the rich in society having access to it. In Africa, an estimated 60 - 70% of the population lives in slums. And with the current urbanization rate, this may amount to about 1.2 billion individuals by 2050 (World Bank Group). Housing Futures estimates that the Middle East needs about 3.5 million housing units to cater for its population. The requirement for housing is especially high for low income families. The challenge thus, is finding means of alleviating this problem. In doing that, it is of utmost importance to prioritize environmental sustainability. This project addresses these challenges by designing a one-story house that will be environmentally sustainable, structurally durable and resilient, and most importantly low cost that it should be affordable for the low-income communities. The scope of the project involves selection and testing of materials to be used in

the design. The tests conducted include the three-point flexure test, the compressive strength test, shrinkage test and thermal conductivity (insulation) test. Materials considered for this project include bamboo, timbercrete, papercrete, mycelium fibers, desert sand bricks, and triple glazed glass. Structural analysis and design is done with SAP 2000, and in accordance with ASCE – 7 10 and IBC building codes. Additionally, the architectural design of the house are such that it optimizes natural air circulation and illumination to reduce the energy demands of the house but also be aesthetically pleasing and blend in with the rest of the structures around it.

- reefRover

Students: Daniel Carelli, Jovan Jovancevic, and Kyler Meehan

Related to Energy and Environment Grand Challenge Theme

Coral reefs in the UAE are under threat of disappearing, due to rising sea temperatures. Despite the importance of studying the response of coral and marine life to the changing climate, marine researchers are not equipped with the personnel or time to survey the reefs on a large scale. Existing methods for coral monitoring are limited, compromising either on accuracy and detail, as with remote sensing, or time and efficiency of data collection, as with manta tows and SCUBA transects. The reefRover project aims to provide a solution to this problem in the form of an autonomous ROV that performs transects along the reef and obtains high-quality images of the coral in the UAE. The ROV is developed in a manner that enables community divers to deploy the device while ensuring data quality, and the reefRover project is kept open-source, allowing anyone across the world to develop and deploy the reefRover and expand the available data on coral reefs. The system is divided into three main efforts -- Underwater Navigation System, Image Processing, and ROV Integration -- and the final system is a fully operational, autonomous ROV for deployment.

- Single Cell Analysis of Algal cells using a Cytometer that Employs a Closed Loop Channel

Student: KataDaki Aishi Mbowe

Related to Joy of Living Grand Challenge Theme

The purpose of this capstone is to develop a cytometer that will perform single cell analysis of algal cells. Conventional Cytometers provide information corresponding to the Eulerian specification of flow field, i.e., properties of groups not individual cells. Our project involves the design of Lagrangian cytometer can track the properties of each and every cell within the population over the growth period and can provide insight into the dynamics, heterogeneity, and hierarchy of

the cell populations between individual cells. The capstone design enables measurement of lipid production in algal cells upon genetic manipulation. This cytometer also enables rational selection and metabolic engineering of microalgae necessary for the optimal production of biofuels.

ethical positions. By considering case studies drawn from Asia, Africa, South and North America, and Europe, this course explores the heated politics of answering these questions. Given today's predominance of Global Health programs that aim to universalize evidence-based medicine (EBM) and to deliver public health via randomized control trials (RCTs), particular attention is paid to assessing these approaches from the vantage of their "target populations."

CCOL-UH 1020 Water

Water is the life blood of existence. Across time and place it has sustained society, nourished crops, made war, diffused networks of trade and cultural exchange, delimited political jurisdictions, and powered machines. Whether tranquil, in motion, or in modes of manipulation, water has also inspired many worlds of artistic practice. This course uses examples from the visual and performing arts to highlight the subject of water as element, energy, human right, bridge between cultures, and instrument of war. Films include *Drowned Out* by Arundhati Roy, *Even the Rain* by Icar Bolla.n, *Water* by Deepa Mehta, and *Black Water*. Performing arts include plays such as *Fire on the Water*, a fast paced series of short plays inspired by a pivotal moment in Cleveland's history created by diverse playwrights; *Water by the Spoonful* by Quiara Alegria Hudes; and *The Water Carriers* by Michael Williams. These works highlight representations of water, the technologies deployed to shape such representations, and their larger role in illuminating big questions about the human condition.

CADT-UH 1001 Manus et Machina

This course explores how technology and machines have influenced human life across the ages. It further explores how technology has influenced the fields of arts and design and investigates this inspirational source for new technological developments. Lecture and discussion will be the breeding ground for concept development of new machines: Every student will realize a prototype of a machine executing a certain task. This hands-on project will be complemented by case studies, reading assignments, workshops, excursions, and one-on-one meetings with the professor. The course builds knowledge about futuristic developments and their use and influence from past to present, including questions concerning ethics and values. Students will leave the course with a completed project to be displayed in an exhibition and a personal philosophy of Arts, Design, and Technology.

CADT-UH 1002 Nature of Code

Can we capture the unpredictable evolutionary and emergent properties of nature in software? Can understanding the mathematical principles behind our physical world help us to create digital worlds? This class focuses on the programming strategies and techniques behind computer simulations of natural systems. In it, students explore topics ranging from basic mathematics and physics concepts to more advanced simulations of complex systems. Subjects covered include forces, trigonometry, fractals, cellular

automata, self-organization, and genetic algorithms.

CADT-UH 1005 Creativity and Innovation

Is creativity a gift or a skill? Can creativity be learned? Because creativity is deeply personal, this course will address these questions through individual and collective experiences. The heart of this course is the Personal Creativity Project— an opportunity for students to practice creativity by designing and executing a project of their choice. The project may be on any topic, from art and music to computer programs and business model development. The project will be complemented by reading assignments (completed prior to class), class discussions, and one-on-one meetings with the instructor. Students will leave the course with a completed project and a personal philosophy of creativity, based on the fusion of readings, study, discussion, and experience. The course provides a great deal of freedom for learning and does not provide step-by-step instructions. As a result, the successful completion of this course will require a significant amount of self-motivation.

Appendix 4 –

NYUAD Approach to Innovation and Invention

A. ENGR-UH 1021 Design and Innovation (Required Course for all Engineering First-Year Students)

This engineering course is an intensive introduction to innovation philosophies and practices around the broad realms of the iterative design process (discover, ideate, make, expose). The majority of the course revolves around hands-on team-based challenges that expose students to multiple engineering domains (electronic, software, mechanical...) as well design domains (design thinking, visual-design, rapid prototyping, product-design, industrial-design). The course culminates in a final innovation and prototyping challenge, the outputs of which are presented in a public exhibition. The course touches on cultural, societal, ethical, and economic factors that must inform the innovation process to maximize its positive social impact.

This is required course for all engineering first year students, and is held during the J-Term (January term) in an immersive format. It uses the extensive resources of the Engineering Design Studio, a 24X7 4,000 sq. ft. state-of-the-art facility that allows students to design, innovate and prototype their ideas. The Engineering Design Studio is described below.

B. Engineering Design Studio

The Engineering Design Studio at NYU Abu Dhabi supports ambitious student projects across the university through coursework, mentorship, and engagement with external partners. Students are challenged to undertake problem solving through the lens of engineering while combining methods and techniques from design to create elegant and mindful outcomes that go beyond merely computing technically correct answers.

As such, the lab is home to the Engineers for Social Impact program projects and the Design and Innovation program, and serves as a hub of activity for engineering Capstone project work, teams preparing competition entries, and student interest groups.

Within the lab, tools and resources are available to transform ideas into prototypes; however, it is not a “Maker Space” in the traditional sense. Instead of primarily focusing on technical training and access to equipment, emphasis is placed on idea generation, refinement of concepts, and selection of effective strategies to realize worthwhile goals. The next generation of engineers is given the space and time needed to develop the poise and confidence to be prepared to initiate and deliver socially responsible and culturally relevant responses to the most challenging design prompts.

The Engineering Design Studio tirelessly promotes student endeavors and provides a learning framework that goes beyond theory in which initiative, resourcefulness, critical thinking, and perseverance are key drivers to success. Since the inception of the lab,

students have created open source projects, filed and received patents, won national and international awards and competitions, worked with partners in government and industry, and received grants and awards totaling more than AED 2.1 million.

Details and photographs of the ideaLAB Engineering Design Studio can be found at:

<https://nyuad.nyu.edu/en/academics/divisions/engineering/academic-programs/engineering-design-studio.html>

C. Patenting and Publishing Support

NYUAD encourages and supports student applying for patents for their inventions. An in-house patent team, supported by the NYU Office of Industrial Liaison (OIL), assists in preparing the application of US patents (<https://med.nyu.edu/oil/frontpage>). Several undergraduate patents resulting from the Design and Innovation course projects, as well as from Capstone and other projects have been filed over the past eight years and some have already been granted.

The engineering division also actively encourages students to present their work in regional and international conferences, and to publish in peer-reviewed journals. Travel support is available via application. Every academic year there are several presentations at conferences by students, and some journal publications.

An illustrative list of patents granted to undergraduate engineering students is as follows:

- Blind Aid Device

US Patent number: 9704414, granted July 11, 2017

Inventors: Undergraduate Students: Jad Mahmoud, Nahal Mustafa, Noha Alfergani, Brenda Odhingo; Faculty Mentors: Ramesh Jagannathan, Matthew Karau (based on their project from Design and Innovation class)

Abstract: A blind aid device designed for non-verbal communication between a blind person and a companion includes a body-worn sensor system to be worn by the companion, a body-worn actuation system to be worn by the blind person and a wireless communication link between the body-worn sensor system and the wearable body-worn actuation system. The body-worn sensor system includes a gyroscope configured to detect and record a velocity of tilting and turning head movements of the companion, an accelerometer configured to detect and record an extent of the tilting head movements of the companion, and a magnetic compass sensor configured to detect and record an extent of the turning head movement of the companion. The wearable body-worn actuation system includes an array of control electronics and actuators configured to translate electronic signals transmitted from the body-worn sensor system into physical movements, in real time.

- Tracking Movement of a Writing Instrument on a General Surface

US Patent number: 9354725, granted May 31, 2016

Inventors: Undergraduate Student: Abdelrazak S. Al-Sharif, Faculty Mentors: Mohamad Eid, Abdulmotaleb El Saddik (based on Senior Capstone project)

Abstract: Methods, systems, and apparatuses, including computer programs encoded on computer-readable media, for capturing, using a camera, an image of a general writing surface. The captured image is compared with one or more previously saved images. A related image is determined based upon syntax and semantics of handwriting recognized in the captured image and the one or more previously saved images. A previous document associated with the related image is retrieved and set as the active document. A position of a writing instrument is mapped to a position within the previous document.

- Song Selection based upon Axial Pen Pressure

Patent number: 9035743, granted May 19, 2015

Inventors: Undergraduate Students: Mohammed Yaseer Omar, Abdel Razzaq Sami Alsharif, Faculty Mentor: Ramesh Jagannathan (based on their project from Design and Innovation class)

Abstract: Methods, systems, and apparatuses, including computer programs encoded on computer readable media, for determining, using a pressure sensor, pressure data comprising a pressure indication and a time indication. A first mood is determined based upon the pressure data and one or more songs are selected based upon the determined first mood. A playlist is modified based upon the selected one or more songs, wherein the modified playlist comprises the selected one or more songs and the modified playlist is played. Song data, based upon the modified playlist, is wirelessly transmitted to a remote device.

Appendix 5 –

NYUAD Approach to Business/Entrepreneurship

A. Leadership and Entrepreneurship courses

NYUAD offers several courses related to leadership, innovation, and entrepreneurship. These can be taken by students as general electives. A sampling of such courses is presented below. A comprehensive list, as well as course descriptions, are found in the University's bulletin:

<https://nyuad.nyu.edu/content/dam/nyuad/academics/undergraduate/bulletins/bulletin-2019-2020.pdf>

LEAD-UH 1001 Critical Issues in Social Entrepreneurship: Innovations in the Middle East

Social Entrepreneurship is a dynamic and growing field that may be defined in various ways, yet at its core is about using evolved business thinking and practices to change the world. This course provides an introduction to the topic through discussion of how social entrepreneurs develop their ideas of social and environmental innovation, how they fund/finance their ventures, the ways in which they overcome the challenges of integrating various levels of economic performance with social/environmental impact and the types of organizations social entrepreneurs create (for-profit, non-profit, cooperative, hybrid, etc.). Through a “deep dive” case study of a leading social enterprise, Sekem Group in Egypt, students will explore the relevance of social entrepreneurship in a changing world and heighten our understanding of the potential we each hold to be “change makers.”

LEAD-UH 3001 Business Acceleration and Disciplined Entrepreneurship

This course provides a framework for teams to move from an idea about a product or service to forming a viable company. Students will walk through initial customer discovery, market size, customer value, marketing to customers and many other areas. The process will allow students to understand their idea, the competitive landscape, the scale and economics of their potential business and have a sense of customer needs as it relates to their product or service.

BUSOR-UH 1001 Principles of Marketing

LAW-UH 2120 Law in Entrepreneurship

SOCSC-UH 1111 Markets

SRPP-UH 1613 21st-Century International Human Rights

SRPP-UH 1617 Sociology of Entrepreneurship

SRPP-UH 2619 Leadership and Diplomacy

SRPP-UH 2620 Education and Society

B. startAD

NYUAD also conducts a program called startAD which offers workshops, open to engineering students, to encourage entrepreneurial thinking and develop the skills needed to turn innovative concepts into realistic business plans.

Each year the startAD campus center offers the following programs (enrolling both students and others from the community, permitting interaction between NYU students and local entrepreneurs and business people) which offer training in key areas needed for entrepreneurial success.

1. Founder School: A series of videos covering foundational aspects of entrepreneurship.
2. Beyond the Pitch: Three-month startup program for NYU and UAE students.
3. StartINVEST: Quarterly investment literacy training sessions.
4. Venture Launchpad: Ten day accelerator for seed-stage startups.
5. Al Warsha: Prototyping and DIY lab for seed-stage startups.

All of the programs, as well as additional support for students with entrepreneurial projects, are easily and regularly available to all NYUAD engineering students throughout the year. Any project a student is working on is eligible for the support services of the startAD Center at no cost.

Details about the startAD program are available at the following website:

<https://sites.nyuad.nyu.edu/nyuadstartad/>

C. Entrepreneurial Competitions (Technical and Business)

NYUAD students are encouraged and supported to participate in technical and business competitions. Each year NYUAD engineering students participate in regional and international competitions of entrepreneurship on both technical and business levels. Competitions where NYUAD students have recently won prizes or awards include:

- Hult Global Case Challenge Competition (<http://www.hultprize.org/>)

Under the mentorship of Prof. Ramesh Jagannathan of NYUAD Engineering Division, a team of NYUAD engineering sophomores won the top prize of \$333,333 for solar lighting scheme in 2012. The prize was awarded by President Clinton. See news links below:

<https://nyuad.nyu.edu/en/news/latest-news/honors-and-awards/2012/april/nyuad-team-wins-hult-global-case-challenge1.html>

<https://nyuad.nyu.edu/en/news/latest-news/honors-and-awards/2012/september/clinton-s-case-for-optimism-includes-nyuad-hult-challenge-winner.html>

<http://content.time.com/time/magazine/article/0,9171,2125031,00.html>

Every year student teams from NYUAD participate in the competition under the mentorship of Prof. Jagannathan. In 2014 and 2019 they reached the final regional competitions, but not the global.

- International Genetically Engineering Machine Competition (<https://igem.org/>)

Teams comprising of engineering and science students, under the mentorship of Engineering Prof. Rafael Song, have been participating in the competition since 2016. NYUAD team won the Silver Medal in the final held in Boston in 2016, and Gold Medals in 2017 and 2018, respectively.

- Drones for Good Competition and Award (<https://www.dubaifuture.gov.ae/our-initiatives/drones-for-good-award/>)

Teams of engineering students have been participating in this competition since its inception in 2015. In 2015 the NYUAD team “Wadi Drone” won the top prize of 1 million Dirhams. In subsequent years the teams have reached the finals, including the Capstone project “reefRover” described earlier.

Appendix 6 –

NYUAD Approach to International Experience and Global Education

A. Educational Vision and Value of the NYUAD Global Education Program:

Global education is an essential component of NYU Abu Dhabi’s educational mission and curriculum. It is realized through a careful sequence of interrelated academic and intercultural experiences over four years that foster greater intercultural understanding toward social responsibility— globally and locally. They are designed to advance our students’ ability to:

- respect, engage, and negotiate difference toward greater common ground and common good and
- act with ethical intelligence as responsible, local citizens and leaders in communities they engage in the UAE, abroad, and at home.

Just as the development of critical thinking skills is not produced in one course but through a process of intellectual and social maturation over multiple years, a global education is not the product of a single experience abroad or more generally traveling. It is cultivated through well guided, iterative interactions with otherness. It is produced through bringing critical reflection and disciplined analysis to those experiences. It manifests in the ability to ask and respond to questions of global human significance with an ever more unprejudiced mind.

Through the network of academic centers and portal campuses that constitute global NYU, students have the benefit of resources, intellectual circles, research centers, and place-based learning that is not available in Abu Dhabi (or any other single site) but is essential to training globally minded, action-oriented leaders and humanitarians. The carefully constructed learning environments abroad are laboratories as important within the liberal arts and sciences context as a state of the art chemistry laboratory, an art studio, or a biological field station. These are study abroad laboratories for producing higher levels of reflective judgment, intercultural sensitivity, and skills of cross cultural communication, conflict resolution, and peacemaking.

In collaboration with divisions and offices at NYUAD, an even broader stage is set for global education at NYUAD through an admissions process that brings together students from a broad range of national and cultural backgrounds, a core curriculum that provides theoretical framing for understanding significant questions through a broadly global lens, student life programming that fosters intercultural communication, and local community engagement through volunteer, internship, and undergraduate research opportunities. From this important academic grounding in Abu Dhabi, NYUAD moves students into the broader global context through study away semesters, J-Terms abroad, and regional

academic programs and helps them bring back to NYUAD the benefit of that learning abroad.

B. Study Away for Engineering Majors

The Engineering Program is relatively structured, and study away opportunities are possible only at sites where relevant engineering courses are available. Engineering students have the widest range of engineering courses if they choose New York as the study away site. All junior Engineering majors typically study away at NYU New York's Tandon School of Engineering in the spring semester of Junior year. Additionally, Engineering majors can also apply for a sophomore-fall study away semester at NYU Shanghai if they place into Multivariable Calculus during the Marhaba Math Placement Assessment and are, thus, able to begin the Foundations of Science sequence in their first semester at NYU Abu Dhabi. Both study away options require the completion of all FOS courses in Abu Dhabi prior to the study away semester. The NYU Shanghai option additionally requires MATH-UH 1020 Multivariable Calculus be completed in Abu Dhabi prior to the study away semester. To be able to study away at NYU Tandon during the Spring of the Junior year, they must also have passed MATH-UH 1024 Fundamentals of Ordinary Differential Equations prior to the study away semester. Additionally, students should have completed their required junior-fall disciplinary courses prior to studying in New York to be able to take full advantage of the Tandon course offerings.

C. Description of Global Programs and Services

The Office of Global Education and Outreach administers semester away, January Term (J-Term), regional academic programs, summer programs, and community-based learning programs in the UAE. The Office provides essential mobility, visa, and on/off-boarding services for new and returning undergraduate students. In all these areas, it focuses on creating sustainable, scalable, cost-effective models and systems that maximize intercultural learning, promote safety and health, and help students contribute as responsible global citizens in the communities they join – wherever they are.

Semester Abroad

Over their four undergraduate years, NYUAD students are fully supported to study abroad for up to two semesters. Support includes funding for tuition, room, board and travel. Almost 100% of NYUAD students in all majors spend at least one semester in one of the NYU Global Program sites in Accra, Berlin, Buenos Aires, Florence, London, New York, Madrid, Paris, Prague, Shanghai, Sydney, Tel Aviv, and Washington DC. At each site, NYU owns or leases its own facilities, creates a curriculum that allows for equivalent courses with those at NYUAD, and appoints well qualified faculty. Another 56% of the NYUAD student body spends a second, research focused semester away. Engineering students generally spend their junior spring semester at the NYU Tandon School of Engineering in

New York to take the wide array of engineering courses in their areas of specialization and prepare for their capstone research projects. On a competitive basis, engineering students may also spend the fall of their sophomore year at NYU Shanghai.

Visiting Student Circulation in the NYU Global Network

NYUAD further increases the diversity of its already highly diverse student body through bringing students from NYU New York and NYU Shanghai to spend a semester or year at NYUAD. Through close collaboration on curriculum development, course equivalencies, and pre-requisites, NYUAD Engineering, for example, has made it possible for visiting students to take advantage of offerings across the Engineering disciplines at NYUAD, allowing those students to stay well on track for graduation even while studying in Abu Dhabi. NYUAD also hosts short-term visiting student groups from NYUNY through in tailor made, one- to three-week, intensive programs (e.g. MS in Risk Management Module for NYU Stern School of Business.)

January Term (J-Term)

All NYUAD undergraduates must take three January Term courses over their four years. These intensive, three-week courses (value of 4 credits each) are staged in over 24 countries and feature a place-based, experiential learning pedagogy. One course spends all three weeks in the site abroad. A second focuses deeply for three weeks on Abu Dhabi and the UAE as case studies. The third is based in Abu Dhabi and includes a week-long seminar in the broader Middle East and Indian Ocean neighborhood of the UAE. The courses provide ideal environments for field research, arts practice, ethnographic inquiry, and other culturally immersive, context-specific course activity. Topics for the courses vary each year, allowing the J-Term to serve as a pedagogical laboratory and springboard for curricular innovation. Engineering student Israel Desta from Ethiopia claims his art history course “Ideas of the Portrait” held at NYU London and making broad use of world famous museums was one of the most formative in his time at NYUAD.

Regional Seminars

In addition to the regional seminars featured in J-Term, NYUAD faculty may apply to conduct a regional seminar for a course during the semester. This is often a keystone, midstone, or Capstone experience for students. In academic year 2017-18, NYUAD facilitated 21 regional seminars in 10 countries in the semesters and 19 seminars in 13 countries during J-Term. The NYUAD Engineering Division has taken advantage of this funding to feature a regional seminar as a required part of the first-year curriculum and an elective component of the second year curriculum. Known as Engineers for Social Impact (Efsi), the seminar is designed as a semester-long course (1 credit for first years and 2 credits for second years) that focuses on experiential learning. The first-year course focuses on ethics and ethnography. Students spend 7 days in Jordan, Sri Lanka, or India working on a community development project in collaboration with Habitat for Humanity

and conducting ethnographic research in the villages to deepen their understanding of the engineering context, challenges, and local solutions. The second year course focuses on design challenges as presented by members of the Dharavi community of Mumbai, India in collaboration with an urban engineering company called URBZ. Over one week during spring break, students take part in a mobile design lab in Dharavi that results in community-based design solutions that are then brought back to NYUAD for development and returned to the community for critique and business entrepreneurship at the end of the semester.

Summer International Internships and Undergraduate Research

On a competitive basis, NYUAD supports students to pursue 8-10 weeks of internship or undergraduate research in the UAE, the US, their home countries, or otherwise abroad. In summer 2018, nearly 40% of the student body received NYUAD funding to pursue internships or undergraduate research in over 30 countries. These intensive experiences have proven exceptionally helpful in the career development process as well as securing jobs and graduate school placements.

Community-based Learning in the UAE

Since 87% of the NYUAD student body is not from the UAE and come from 118 countries, they begin a four-year study abroad in an international context from their first day at NYUAD. The University provides ongoing cultural orientation programs and other ways to connect students within the UAE community through volunteer opportunities, cultural activities, intercultural communication training, Arabic language instruction, and over 120 courses each year that include a community-based learning component in the UAE.

Appendix 7 –

NYUAD Approach to Service Learning

A. Opportunities through NYUAD Office of Community Outreach

The Office of Community Outreach (OCO) develops mutually beneficial partnerships to foster a deep commitment to civic engagement and service. OCO designs volunteer opportunities to help students engage with the UAE through meaningful community involvement, embrace the rich diversity of the Emirates, and cultivate social and inclusive leadership to strengthen their local regional and global communities.

Students can expand their community network and feel more at home by joining local festivals and volunteering for some of the capital's most prominent cultural and educational events such as Abu Dhabi Art, Abu Dhabi Science Festival, or Abu Dhabi Festival.

Students interested in engaging with the Abu Dhabi community on a deeper level, while gaining valuable work experience can volunteer for sustained Service Based Learning Programs that require a semester-long commitment. They can help teach athletics skills to young children with autism with the Special Needs Athletic Program (SNAP), mentor young girls to explore leadership through the Girls' Education Network (GEN) or Boys' Education Network (BEN), or tutor migrant workers to improve conversational English skills with Strength in Vocational Education (STRIVE). In response to students looking to gain experience in nonprofit administration, the OCO has developed a robust and sought-after internship program.

Our Social Impact Leaders speaker seminars helps connect students to inspiring social change thought leaders, through intimate conversations with guest lecturers such as the legendary Dr. Jane Goodall, Nancy Lublin, Celine Cousteau, or Robart Swan. NYUAD has joined prominent global educational campaigns such as Breast Cancer Awareness and Autism Awareness Month. Students that are driven by social purpose, what we call "NYUAD Heart", are advised, supported and empowered through the office.

B. Engineers for Social Impact Program

Engineers for Social Impact (EfSI) supports and complements the mission of the Engineering Division and the broad goals of NYUAD through courses that emphasize experiential learning and projects that focus on developing globally-relevant, locally-sustainable designs that meet challenges and deliver on opportunities that enable individuals across global communities to more effectively realize their aspirations and ambitions.

By engaging with ethics in the classroom and ethnographic fieldwork off-campus, engineering students expand their comfort zones to work from vantage points of broader

mindfulness of social, cultural, and economic aspects that are inextricably connected to technology-driven solutions in today's hyper-connected world. Students may optionally enroll in a second, project-driven course focusing on the process of co-designing meaningful innovations, projects, and products with members of a selected community. Throughout all fieldwork, the goal is to connect with the processes, people, sights, sounds, experiences, and stories that are only accessible outside the classroom and bring new understanding to bear on the ways to address a wide range of issues and challenges in the courses and beyond.

The EfSI program is a collaboration between the Engineering Division and the Office of Global Education to deliver unparalleled international engagement with communities through partnerships with the Solar Energy Foundation in Ethiopia, URBZ/Urbanology in Dharavi, Mumbai, and Habitat for Humanity in Jordan, India, Sri Lanka, and Thailand.

The first year engineering students are required to participate in a week-long immersive experience during the Spring break. Student groups live within a community and participate in community based projects such as building houses with Habitat for Humanity NGO. In the subsequent years, EfSI projects tackle student-identified projects in communities across the globe. These second year EfSI projects are optional and can be done by students in sophomore, junior, or senior years.

More details are found in the following website:

<https://nyuad.nyu.edu/en/academics/divisions/engineering/academic-programs/engineers-for-social-impact.html>

Appendix 8 –

Application to the NYUAD Grand Challenge Scholars Program

Mockup of Application Form

Before filling the application, please consult the NYUAD Grand Challenge Scholars Program website at [TBA](#).

Please fill in the form below to apply to the NYUAD Grand Challenge Scholars Program.

When you have completed this application, please email the **form** as well as your application **essay** to nyuad.GCSPDirector@nyu.edu.

Name: _____ Division and Major: _____

NYU NetID: _____ NYU N Number: _____

Phone: _____ Anticipated graduation year: _____

Email: _____

If you have completed your first year, please indicate the following

GPA: _____ Academic Advisor*: _____

(*Your academic advisor will be asked to write a recommendation letter)

Which Grand Challenges(s) most interest you? Please put a number next to the GC that you think you might be interested in. Number 1 indicates the most interested one, and 2 as the next favorite and so on.

Grouped into four larger themes, these challenges are:

Energy and Environment Grand Challenge Theme:

____ (1) Make solar energy economical

____ (2) Provide access to clean water

Health Grand Challenge Theme:

____ (3) Advance health informatics

____ (4) Reverse Engineer the Brain

Security Grand Challenge Theme:

- ____ (5) Secure cyberspace
- ____ (6) Restore urban infrastructure

Joy of Living Grand Challenge Theme:

- ____ (7) Enhance virtual reality
- ____ (8) Engineer the tools of scientific discovery

More information about the Grand Challenge can be found through this link:
<http://www.engineeringchallenges.org/GrandChallengeScholarsProgram.aspx>

If you have a preference for particular faculty members to be your GCSP Mentor, please specify below (if no preference, please write NA):

1st Choice _____

2nd Choice: _____

Please indicate in the space below why you prefer to work with the Mentor(s) listed above.

Essay: Please help us get to know you and understand your motivations for becoming an NYUAD Grand Challenge Scholar by writing an essay (of approximately 500 words) in which you discuss why you wish to become a Grand Challenge Scholar, which of the theme(s) and challenge(s) you are most interested in most and why, as well as what you would bring to the Grand Challenges Scholars Program.

Appendix 9 –

Assessment

Assessment Form to Record Student Progress toward GCSP certificate

STUDENT NAME	NET ID	GCSP MENTOR

Five Competencies	Requirements to Certify Competency (* must include a written report by supervising faculty ** student must submit report)	Date of Completion of Requirement	Evaluation (1 to 5, deficient to excellent)
1 - Research / Creativity	<ul style="list-style-type: none"> ○ Design and Innovation COURSE ○ ___ 2 semester Senior CAPSTONE Design Project on a topic related to the GC theme chosen by the student,** OR ○ ___ Approved SUMMER RESEARCH related to GC theme,* OR ○ ___ Approved SECOND YEAR EFSI PROJECT related to GC theme* 		
2 - Multidisciplinary	<ul style="list-style-type: none"> ○ GCSP INTRODUCTORY WORKSHOP ○ At least 1 ELECTIVE or CORE COURSE aligned with the chosen GC theme, course number: _____ 		
3 – Business /Entrepreneurship	<ul style="list-style-type: none"> ○ START AD COURSE / WORKSHOP, registered and completed: _____* ○ ___ Approved INTERNSHIP or RESEARCH PROJECT explicitly including innovation, invention, or entrepreneurship,* OR ○ ___ Participate in approved BUSINESS PLAN COMPETITION: _____* 		
4 - Global / Multicultural	<ul style="list-style-type: none"> ○ One SEMESTER OVERSEAS and have a CULTURAL EXPERIENCE in addition to technical courses** ○ ___ NYUAD INTERNATIONAL J-TERM, course number: _____, OR 		

Five Competencies	Requirements to Certify Competency (* must include a written report by supervising faculty ** student must submit report)	Date of Completion of Requirement	Evaluation (1 to 5, deficient to excellent)
	___ Approved INTERNATIONAL SUMMER SCHOOL , OR ___ Approved FREE ELECTIVE COURSE that addresses global / multicultural, course number: _____		
5 – Social Consciousness	<ul style="list-style-type: none"> ○ Participate in a SERVICE OPPORTUNITY provided by the NYUAD OCO** ○ Participate in first year ENGINEERS FOR SOCIAL IMPACT (EFSI) project* 		

Appendix 10 —

CV of Designated Inaugural Director of NYUAD GCSP

Sunil Kumar

Division of Engineering
New York University Abu Dhabi
Saadiyat Island, Abu Dhabi, UAE

+971-2-628-4033
sunil.kumar@nyu.edu
<http://engineering.nyu.edu/>

Education

University of California, Berkeley	Mechanical Engineering	PhD	December 1987
State University of New York, Buffalo	Mechanical Engineering	MS	August 1984
	Applied Mathematics	MA	August 1984
Indian Institute of Tech, Kharagpur	Mechanical Engineering	BTech	April 1982

Research and Academic Experience

8/15- Global Network Professor, New York University, Abu Dhabi.
8/15- Vice Provost, New York University, Abu Dhabi.
8/02- Professor, Mechanical Engineering, Tandon School of Engineering, New York U.
8/09-8/15 Dean of Engineering, New York University, Abu Dhabi.
8/03-12/13 Associate Provost, Polytechnic Institute of New York University*, Brooklyn, NY.
8/03-1/11 Dean of Graduate School, Polytechnic Institute of New York University*, NY.
6/96-8/00 Department Head, Mechanical Aerospace Manufacturing, Polytechnic Univ*.
6/94-8/02 Tenured Associate Professor, Polytechnic University*, New York.
12/92-5/95 Co-Director, Energy Systems Laboratories, Polytechnic University*.
1/90-5/94 Assistant Professor, Polytechnic University*, New York.
6/89-8/89 Visiting Scientist, NASA Ames Research Center, California.
6/88-1/90 Research Staff, Lawrence Berkeley Laboratory, California.

* Now: Tandon School of Engineering, New York University, Brooklyn, New York, USA.

Editorships

- o High Temperatures – High Pressures: The International Journal of Thermophysical Properties Research, Editor.
- o Journal of Enhanced Heat Transfer, Associate Editor.

Honors and Memberships

- o Elected Fellow of the American Society of Mechanical Engineers
- o Elected Member of Tau Beta Pi, the Engineering Honor Society
- o Elected Member of Pi Tau Sigma, the International Honor Society for Mechanical Engineers

Patents

- Rahman, A., Eze, R., and Kumar, S., "Optical Sensor for Measuring Thin Film Deposition in Real Time," US Patent 7,630,590, December 8, 2009.
- Panindre, P., and Kumar, S. "Closed loop microresonators having linear portions and filleted corners, systems including such microresonators, and methods of fabricating such microresonators," U.S. Patent Application No. 62/260,018, November 25, 2015.
- Rajput, P., and Kumar, S., "Directionally targeted jet noise reduction system and method," U.S. Provisional Patent filed February 2018.

Publications: Books

- "Heating, Ventilating, and Air Conditioning Handbook for Design and Implementation," by Ali Vedavaz, Sunil Kumar, and Muhammed Hussain, Industrial Press, New York (2007).

Publications: Monographs and Chapters in Books

- "Biocompatible Nanoparticulate Systems for Tumor Diagnosis and Therapy," by Mostafa Sadoqi, Sunil Kumar, Vishal Saxena, and Cesar Lau-Cam, in *Nanotechnologies for the Lifesciences (Book Series) : Volume 2 [Biological and Pharmaceutical Nanomaterials]*, Editor: C. Kumar, Wiley (2005).
- "Radiative Transfer Modeling and Experiments Using Short Pulse Lasers," by Sunil Kumar, Pei-feng Hsu, Kunal Mitra, Bruce Garetz, Zhixiong Guo, and Janice Aber, in *Modeling and Simulation Based Life Cycle Engineering*, Editors: S. Saigal, K.P. Chong, S.T. Thynell, and H. Morgan, Taylor and Francis (2001).

Publications: Journals and Conferences

- 60+ peer-reviewed Journal papers
- 150+ Conference papers and presentations

Funded Research

- Over \$5.1M of research grants since 2007

Appendix 11 –

Financial Plan to support NYUAD GCSP

Various elements of the proposed NYUAD GCSP are part of ongoing activities of the University (the engineering division, office of global education, startAD) and are included in ongoing regular budgeted expenses. These are:

- Courses: no extra courses are needed Ongoing
- Engineers for Social Impact Ongoing
- Faculty mentorship: part of regular expectations Ongoing
- Summer internship opportunities and funding Ongoing
- Entrepreneurship startAD courses / activities Ongoing
- Support for Engineering Design Studio Ongoing
- Labs and project spaces Ongoing

NYUAD will budget the following in the engineering division for the GCSP:

- 1 course relief for the GCSP Director or 1 month summer salary
- Summer support (by application) for students participating in immersive startAD activities during summer
- Expenses for annual advisory group meetings
- Expenses for events such as seminars and activities related to GCSP
- Expenses for a faculty member (or Director) and 4 students to attend the GCSP annual meeting

Appendix 12 –

Membership of the NYUAD GCSP Advisory Committee

The proposed membership of the Inaugural GCSP Advisory Committee is as follows:

No.	Name	Affiliation	Email
1	Samer Madanat, Dean of Engineering, ex-officio	NYU Abu Dhabi	samer.madanat@nyu.edu
2	Sunil Kumar, Director of NYUAD GCSP, ex-officio	NYU Abu Dhabi	sunil.kumar@nyu.edu
3	Jelena Kovačević, Dean of Engineering	NYU Tandon School of Engineering	jelenak@nyu.edu
4	Harold Sjursen, Professor of Philosophy	Beihang University	harold.sjursen@nyu.edu
5	Mahir Nayfeh, Partner*	McKinsey and Co	
6	Omran Assa, Vice President Middle East and North Africa*	Bechtel	
7	Naguib Attia, Vice President, Global University Programs*	IBM	
8	Melvina Tarazi, Chief Strategy Office and Vice President*	SAP	
9	Fatma Abdulla, Vice Provost	NYU Abu Dhabi	fatma.abdulla@nyu.edu

* Members of the NYUAD Engineering Advisory Council (EAC)

Since some of the members of the GCSP Advisory Committee are also members of the larger NYUAD Engineering Advisory Council (EAC), the meetings of the GCSP Advisory Committee will be held in conjunction with the EAC meetings to take advantage of synergies and logistical efficiencies.

Appendix 13 —

NYU Abu Dhabi Accreditation

NYU Abu Dhabi is accredited by the Middle States Commission on Higher Education, 3624 Market Street, Philadelphia, PA 19104 (phone: +1-267-284-5000). The Middle States Commission on Higher Education is an institutional accreditation agency recognized by the U.S. Secretary of Education and the Council for Higher Education Accreditation. NYU Abu Dhabi is approved by the Middle States Commission as an additional location of NYU, and is included within the scope of its accreditation.

NYU Abu Dhabi, is officially licensed by the Ministry of Higher Education of the United Arab Emirates to grant degrees and other academic awards in higher education. All degree programs at NYU Abu Dhabi are also individually accredited by the Ministry's Commission on Academic Accreditation (CAA).

In addition to the above, the five engineering majors offered by NYU Abu Dhabi have programmatic accreditation. General Engineering, Civil Engineering, Computer Engineering, Electrical Engineering, and Mechanical Engineering are accredited by ABET (<http://www.abet.org>).