Grand Challenge Scholars Program Operational Document

Faculty of Engineering

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1. Vision

1.1 Introduction to University and Field Study Abroad

University of Rome “Sapienza” is a public university with faculties who are dedicated to teaching and research. The main campus in Rome enrolls approximately 120,000 undergraduate and graduate students. Regional campus locations include Civitavecchia, Latina, Rieti, Frosinone, Nettuno, Viterbo in Italy and Buenos Aires in Argentina. Engineering at the main campus is housed within six departments, with eleven undergraduate programs and sixteen master’s degree programs. Students typically complete their BS degree in 3 yrs, and complete a master’s degree in the subsequent 2 yrs, completing a total of 5 yrs of study; the Italian high school is a 5 yr program. Enrollment is approximately 1,500 undergraduates and 1,000 graduate students.

Sapienza’s Engineering program has a long tradition of teaching, research, and collaboration with industrial partners, with a long academic tradition of providing students with a strong scientific grounding in core subjects. Sapienza offers an innovative syllabus with solid foundations in a wide variety of sub-disciplines and focuses on the sustainability of both the natural and built environments. Students gain vital professional skills for employment in both the domestic and increasingly globalized job markets. Some of the courses on offer include: Civil and Environmental Engineering, Aerospace and Mechanical Engineering, Conservation and Restoration Engineering, Chemical and Materials Engineering, Management and Security Engineering, Building Engineering and Architecture and other innovative programs that provide students with the opportunity to explore new topics in the field of renewable energy sources and power plants, nanotechnology, transportation and bioengineering. Sapienza organizes the State Exams of Accreditation which is legally required in order to practice the engineering profession in Italy. Engineering graduates influence the future through innovative design and construction of new infrastructure in Italy and around the world.

The values of Sapienza Engineering are to contribute to find solutions to grand challenges and improve the world. Sapienza imbues in engineering students an awareness and ability to contribute to the research and development of shared solutions for the construction and maintenance of sustainable futures. A solid knowledge and a particular attitude for a complex methodological approach is trained: the ability to identify the data of a problem and use it to prevent the response; the ability to distinguish between necessary and sufficient conditions and link the results to the hypotheses that determine them, one example is the Field Study Abroad experience (promoted by Energy Didactic Degree Committee), that is 1-month experience in developing Countries. It is mainly held in poor communities where development is driven by sustainable energy projects and environment-friendly actions. Participants are involved in proactive initiatives through group works and field activities like impact evaluation, data collection, projects writing, stakeholders’ engagement.

The Field Study Abroad takes place in Latin America (Honduras, Guatemala, Costa Rica) and East Africa (Rwanda, Uganda, Kenya) and it is perfectly matching with the NAE GCSP aims and values, since multiculturality and interdisciplinarity are the main cores of this formative experience. The course has been awarded at the presence of the Italian President of Republic
as an outstanding high-level training experience and it is already considered by the faculty an extension of the Energy Systems classes in the Energy Engineering Degree.

1.2 Vision for a Grand Challenge Scholars Program

The vision of our National Academy of Engineering (NAE) Grand Challenge Scholars Program (GCSP) is to make the world more sustainable, safe, healthy, and joyful, sharing the vision of the NAE for engineering in the 21st century.

To achieve this vision, our NAE GCSP program will advance solutions of the 14 Grand Challenges identified by the NAE. Given our history of working on United Nations goals, we have noted many of the NAE challenges overlap with the United Nations Sustainable Development Goals. Specific goals of our NAE GCSP are to:

1. Enrich the GCSP student’s experience through exposure to individuals, including those in-residence, who possess significant experience related to a Grand Challenge.
2. Build community amongst the GCSP participants through networking events with students, faculty mentors, and GCSP Steering Committee members.
4. Motivate and equip students to pursue positions or careers that can help solve one or more of the Grand Challenges.
5. Engage in continuous improvement through soliciting feedback from other NAE GCSP members, utilizing the GCSP network.

1.3 Grand Challenge-like topics available to students

Sapienza Faculty of Engineering engage in research related to the 14 NAE Grand Challenges, which are organized into 4 themes, denoted in (), listed below:

1. Make solar energy economical (theme, sustainability)
2. Provide energy from fusion (theme, sustainability)
3. Develop methods for carbon sequestration (theme, sustainability)
4. Manage the nitrogen cycle (theme, sustainability)
5. Provide access to clean water (theme, sustainability)
6. Advance health informatics (theme, health)
7. Engineer better medicines (theme, health)
8. Prevent nuclear terror (theme, security)
9. Secure cyberspace (theme, security)
10. Restore urban infrastructure (theme, security)
11. Reverse engineer the brain (theme, health)
12. Enhance virtual reality (theme, joy of living)
13. Advance personalized learning (theme, joy of living)
14. Engineer the tools of scientific discovery (theme, joy of living)

The NAE GCSP Director Dr. Ramakrishna has mapped how the UN Sustainable Development Goals overlap with the NAE Grand Challenges and their themes. Students involved in the NAE GCSP who wish to advance the UN Sustainable Development Goals must work on technical elements, noting these goals requires engineering, innovation, and policy. UN Sustainable Development Goal #17 is Partnerships for the goals, which fits well with the NAE GCSP. The UN Sustainable Development Goals and themes, denoted in (), are given below:

1. No poverty (theme, security)
2. Zero hunger (theme, security)
3. Good health and well-being (theme, health)
4. Quality education (theme, joy of living)
5. Gender equality (theme, joy of living)
6. Clean water and sanitation (theme, sustainability)
7. Affordable and clean energy (theme, sustainability)
8. Decent work and economic growth (theme, joy of living)
9. Industry, innovation and infrastructure (theme, security)
10. Reduced inequality (theme, joy of living)
11. Sustainable cities and communities (theme, sustainability)
12. Responsible consumption and production (theme, sustainability)
13. Climate action (theme, security)
14. Life below water (theme, sustainability)
15. Life on land (theme, sustainability)
16. Peace and justice strong institutions (theme, security)
17. Partnerships to achieve the goal (with the NAE GCSP)

2. Steering Committee

Sapienza NAE GCSP Steering Committee will be composed of: 1) GCSP Director, appointed by the Dean of the Engineering Faculty; 2) One tenure-line faculty member from one of the six departments in Engineering Faculty; 3) Four professionals engaged in works related to the NAE Grand Challenges, from sectors such as manufacturing, engineering, construction, health care, education and research, agriculture, and industry, working with public, private, governmental or non-governmental organizations.

The GCSP Steering Committee will be responsible for ongoing operation and assessment of the program including recruiting, processing applications, coordination of the GC Scholar in Residence Program, monitoring and assessing of the students and the program. The GCSP Director is responsible for leading the program and chairing the steering committee. The GCSP Director will engage veteran GCSP students as informal mentors for new GCSP students, and responsible for communicating with faculty mentors assigned to GCSP students. The Director is also responsible for compiling the names and accomplishments of students who receive Grand Challenge Scholar designation upon graduation and reporting this information to the national Steering Committee.
The GCSP Director is responsible for overall administration, operation, assessment, and reporting. Operational duties will include program logistics, budget management, scholar selection, and monitoring progress of scholars. Assessment duties include assessment of attainment of learning outcomes for the program.

3. Recruiting

Our plan for recruiting NAE GCSP students is based on a goal of reaching a graduation rate of approximately 30 scholars per year by 2023. In the steady-state we anticipate between 40 to 60 participating students spread over the 2nd through 5th years.

The recruitment process consists of marketing to students, soliciting applications, and providing feedback when needed to strengthen applications. The recruitment will explicitly state our goal to have a diverse set of GCSP students, emphasizing that diversity of backgrounds and perspectives brings better engineering collaboration and design. A GCSP website, hosted by the university, will be established with program requirements, the GCSP application form, model plans of study, and contact information for the GCSP Director. The plan will target the first-year and second-year courses in the Faculty of Engineering and to the university student body.

4. Application and selection

Any Sapienza student of Engineering in good standing can apply for admission to the program. We expect to admit 10 to 15 students each year, from any of the engineering departments at Sapienza. The application process requires students to submit a statement of purpose, identify the Grand Challenge they will pursue, and identify a plan of study showing how they will complete the five competencies of the program.

Applications will be accepted on a rolling basis and reviewed once each semester for admission. Deadlines and announcements will be established to facilitate student's academic planning schedule. Students may apply at any time during their academic career, including 1st year, but we anticipate that most students will apply in their 2nd year in order to show a viable plan of study and requiring a minimum of three semester participation in the program.

Application review and selection criteria will include: 1) A coherent plan of study that supports the student's Grand Challenge theme; 2) A plan that addresses all required GCSP framework components; 3) Feasibility that the plan will be completed successfully; 3) Required minimum three semester participation in the program; 4) The student's motivation as evidenced by their essay. The selection process will strive for an academically strong and diverse cohort of students. The application for our NAE GCSP is attached at the end of this document.

5. Faculty mentors

Sapienza assigns to each Engineering student a faculty mentor to supervise the student thesis, which will satisfy the technical talent competency. Students enrolled in the GCSP will use their thesis research experience to complete the talent competency, focused on research or creativity in one of the NAE Grand Challenges or related United Nations Sustainable Development Goals.
Sapienza has in place a program to recruit, educate, and assign faculty mentors for thesis research, and the majority of Engineering faculty at Sapienza are focused on projects directly or indirectly related to the Grand Challenges and Sustainable Development Goals.

Faculty will be invited to mentor the GCSP students in writing up their findings from the 4 non-technical competencies. The GCSP Committee will instruct faculty mentors how to supervise GCSP students to achieve the 4 non-technical competencies, which involves: 1) identifying and discussing with students the connections between their technical research and the GCSP non-technical competencies that make the difference between researching and actually solving a Grand Challenge; 2) working with students to plan out how they will satisfy their non-technical competencies; and 3) directing students to the GCSP Director for more detailed guidance on how to achieve their non-technical competencies. The GCSP Committee will hold annual faculty meeting to recruit and educate faculty how to complete this mentoring of the GCSP students. The faculty mentors commit to reviewing and editing the GCSP student deliverables for each of the competencies, each as a chapter in their thesis. The review will use a rubric to assess whether the written chapter meets the performance criteria required for the competency, and to determine whether there is thematic continuity between the five competencies. If a GCSP student does not have a faculty mentor able to provide the mentoring of the four non-research competencies, the GCSP Committee will provide that mentoring.

6. Funding support

The Program will have no obligated costs. The GCSP Director is selected by Sapienza to conduct teaching and outreach, and the NAE GCSP activities progress. The faculty mentors will voluntarily mentor students in thesis research, and the training of the faculty will occur within the existing budgeted time for adapting best practices. Travel and research project materials will be paid for using the existing budget lines and rules at Sapienza. Students will provide for any cost incurring in optional activities related to the Grand Challenge Scholar Program (e.g. travel expenses, abroad internships). The GCSP Steering Committee will volunteer their time. The Faculty of Engineering or Sapienza University is not requested to fund any of the activities, materials, advisories or services related to the GCSP.

To enrich the NAE GCSP with new recruitment, training, and outreach experiences, the GCSP Director will seek external donors, philanthropic organizations, and awarded financing from International institution supporting these activities.

7. Five GCSP competencies

Sapienza will create a GCSP experience that is broad, deep, and coherent. To obtain breadth, each student will engage in each of the 5 competencies, with the talent competency at a high level of depth, the other non-technical competencies at medium levels of depth. The talent competency in research and creativity will most likely be integrated into the student's undergraduate or graduate thesis, and will define the Grand Challenge focus of their research or creative project. To obtain connectivity between competencies, the student will select a Grand Challenge, and then use that as the focus of talent competency and the focus of the four remaining non-technical competencies. The students can initially work on the talent or the non-
technical competencies, and do not need to start with the more technical research or creativity effort.

A unique aspect of the Sapienza GCSP is the GC Scholar in Residence program. This will bring to GCSP didactic proposal, once each semester two to four days meetings, with voluntary individuals who possess significant experience related to a Grand Challenge. These will be researchers, engineers, entrepreneurs, and leaders from business, government, non-governmental organizations (NGOs), or others working in a GC area. Visitors will meet with students in small groups, panel sessions, and one-on-one sessions, to address: 1) Current research and challenges in addressing one or more GC problems; 2) Challenges in working at the boundary of engineering and non-engineering disciplines, for example, business or entrepreneurial challenges in bringing solutions to market; 3) Global dimensions, in practice, of the Grand Challenges; 4) The role of NGOs or not-for-profits solving the Grand Challenges; 5) Other relevant topics such as professional ethics, unintended consequences, responsible conduct or other topics in the visitor’s area of expertise, and advice and counseling to students on their GC projects and career plans.

7.1 Talent competency:

Goal: Mentored research/creative experience on a Grand Challenge-like topic.

Activity: Students will complete research as part of their undergraduate or graduate degree requirement, under the supervision of their major professor, on a Grand Challenge-like topic listed in section 1.3 above. The research will be part of a semester project, summer experience, internship, or co-op.

Deliverable: A research report should be submitted as a DOCX or equivalent file, named GCSP-Talent-YYYYMMDD-student last name, where YYYYMMDD and student last name are the date and student specific information.

Performance criteria: The report should be at least 4000 words, not including a cover page, references, figures and tables, or appendices. The report should have the equivalent of: 1) introduction and motivation to the Grand Challenge-like topic; 2) project or research objectives and questions; 3) review of prior research on topic; 4) methodology; 5) results; 6) discussion of how the findings addressed the Grand Challenge-like topic; and 7) conclusion. The quality of the work will be judged by its grammar, organization, appropriateness, accuracy, thoroughness, and documentation, and it should be of sufficient quality to satisfy the undergraduate or graduate thesis requirement.

7.2 Multidisciplinary competency:

Goal: Understanding multidisciplinarity of engineering system solutions developed through engagement.

Activity: Students will investigate how a solution to their Grand Challenge-like topic involves other physical science and social science disciplines. This investigation will be conducted using: 1) engagement in a specific “GCSP suggested course”, such as “Renewable Energy System Design Lab” (that goes beyond technologies toward smart and sustainable way of design as well as social impact and environmental return of each project), or a series of lectures by invited
experts in a topic providing a broad set of ideas beyond their primary disciplinary training such as "Ingegneria Incontra" and others that will be suggested by the committee; 2) literature review to find the contributions of other disciplines to the topic, and 3) reflection on how multiple disciplines can coordinate their contributions to advance a solution. Databases that might be used for the literature review include Scopus and Web of Science, as well as Engineering Village (engineering), ERIC (education), GeoRef (geosciences), Agricola (agriculture), EconLit (economics), NEXIS (law), PAIS International (public policy), PsycINFO (psychology), PubMed (medicine).

Deliverable: A multidisciplinarity report should be submitted as a DOCX or equivalent file, named GCSP-Multidisciplinarity-YYYYMMDD-student last name, where YYYYMMDD and student last name are the date and student specific information.

Performance criteria: The report should be of at least 1500 words, not including a cover page, references, figures and tables, or appendices. The report should have the equivalent of: 1) a section identifying how 3 or more non-engineering disciplines are approaching solutions to the Grand Challenge-like topic, and 2) a section proposing how the engineering research could coordinate with these other disciplines to achieve a more effective team approach to solving the grand challenge-like topic. The quality of the work will be judged by its grammar, organization, appropriateness, accuracy, thoroughness, and documentation.

7.3 Viable Business/Entrepreneurship competency:

Goal: Understanding, preferably developed through experience, of the necessity of a viable business model for solution implementation.

Activity: Students will prepare a business plan to conduct research and development or disseminate a solution for the Grand Challenge-like topic. They will learn to prepare the business plan through a university course in business (entrepreneurship, marketing, etc.) or equivalent experience such as Startup Weekend or entrepreneurship club.

Deliverable: A business plan report should be submitted as a DOCX or equivalent file, named GCSP-Business-YYYYMMDD-student last name, where YYYYMMDD and student last name are the date and student specific information.

Performance criteria: The report should be of at least 2000 words, not including a cover page, references, figures and tables, or appendices. The report should have the equivalent of: 1) a section establishing a compelling set of products or services relevant to Grand Challenge-like topic; 2) a section explaining the business; 3) a section with a market analysis; 4) a section with a strategy for implementation; 5) a section on the management team organization; and 6) a section on the financial plan and projections. The quality of the work will be judged by its grammar, organization, appropriateness, accuracy, thoroughness, and documentation.

7.4 Multicultural competency:

Goal: Understanding of cultures, preferably through a multicultural experience, to ensure cultural acceptance of proposed solutions.
Activity: Students will complete a multicultural experience, participating to a field study experience, or an equivalent experience. For example the traditional FSA involves 4 or more weeks of travel in low income countries, currently in east Africa or Central America, working with groups with high vulnerability and needs. The courses prepare students for effective citizenship in a diverse multicultural society by helping students to recognize new perspectives and their own cultural perspectives and biases.

Deliverable: A multicultural report should be submitted as a DOCX or equivalent file, named GCSP-Multicultural-YYYYMMDD-student last name, where YYYYMMDD and student last name are the date and student specific information.

Performance criteria: The report should be of at least 2000 words, not including a cover page, references, figures and tables, or appendices. The report should have the equivalent of: 1) a section identifying 2 or more cultural perspectives relevant to the Grand Challenge-like topic; 2) a section comparing and contrasting the cultures in how they relate to the Grand Challenge-like topic; 3) a section identifying barriers and opportunities to achieving cultural acceptance to proposed solutions of the Grand Challenge-like topic. The quality of the work will be judged by its grammar, organization, appropriateness, accuracy, thoroughness, and documentation.

7.5 Social Consciousness competency:

Goal: Understanding that solutions should serve primarily people and society, reflecting social consciousness.

Activity: Students will complete a service-learning course or participate with a service organization, governmental, non-governmental, or equivalent, dedicated to assisting people and society affected by the Grand Challenge-like topic. The participation should be focused on characterizing the human or social implications of the problem or solution related to the Grand Challenge-like topic.

Deliverable: A social consciousness report should be submitted as a DOCX or equivalent file, named GCSP-Social-YYYYMMDD-student last name, where YYYYMMDD and student last name are the date and student specific information.

Performance criteria: The report should be of at least 1500 words, not including a cover page, references, figures and tables, or appendices. The report should have the equivalent of: 1) a characterization of the human or social implications of the problem or solution related to the Grand Challenge-like topic; 2) a reflection of how that characterization may be absent or present in the engineering approach taken to addressing the Grand Challenge-like topic. The quality of the work will be judged by its grammar, organization, appropriateness, accuracy, thoroughness, and documentation.

8. Mentorship, support, tracking, and assessment

8.1 Mentorship

The Grand Challenge Peer Mentor program will pair experienced GCSP students with new students seeking peer-to-peer informal mentoring. Mentors will have participated in the program for at least two previous semesters, and have been invited to be a mentor by the GCSP Director.
based on their strong, mature, responsible characteristics suitable for mentoring new students. Mentees will participate in the program for at least two semesters. The goal of the mentor program is to (1) act as a source of networking and support to new GCSP students and (2) provide feedback to the GCSP Director to help identify problems or roadblocks early. The GCSP Director will meet with the mentors once per semester to help prepare them for their role and to solicit feedback to help identify potential problems in the program and improve the program. Peer Mentors may also assist with several of the intramural networking initiatives (such as social media presence) described in section 4.3.

8.2 Support and tracking

Sapienza will support and track students through a required Grand Challenge Experience course, which is a zero credit-hour course each semester, required of all GC scholars as long as they are enrolled in the program. The course assures that all GC students meet particular GCSP requirements, such as submission of progress reports, submission of reflections, participation in the GC Scholar in Residence program, and participation in the peer mentor program. Progress reports and reflections are used for monitoring and assessment of individual student’s progress, encouraging thematic connectivity across the students’ experiences in the program, and for collecting data to assess the program as a whole.

GC students enroll in the course continuously (fall and spring semesters) and must maintain a passing grade to remain in the program. A passing grade requires completion of the non-course requirements that include: 1) Participation in the Grand Challenge Scholar in Residence Program through attendance at presentations, seminars, meals, and other events; 2) Attend required presentations such as capstone or research presentations; 3) Each semester submit a progress report, updated GCS plan of study, and reflection to the GCSP Steering Committee. Progress reports will include any changes to the plan of study which must be approved by the GCSP Steering Committee. Reflections will address how completed experiences connect with the scholar’s grand challenge theme.

The GCSP Steering Committee will use student’s progress reports and reflections to monitor progress toward completion of plans of study, identify possible areas where intervention is needed, and to assess overall effectiveness of the program.

Students will not receive scholarships. Students have the option to use on-campus honors programs, or involvement in clubs and other organizations program to complete all or components of their five competencies.

8.3 Assessment

Assessment of the student work toward completion of the NAE GCSP will be judged relative to the goal, activity, and performance criterial listed for each of the five competencies. The assessment will occur during the Grand Challenge Experience course or at the completion of their degree program.

9. Recognition
The GCSP Director will compile the names and accomplishments of students who receive Grand Challenges Scholar designation upon graduation and convey this information to the national Steering Committee. Sapienza will acknowledge GCSP graduates with a formal certificate, and will announce the student achievement during graduation ceremonies.
Appendix Application Form

Name:
Major(s):
Intended year of graduation:

**Part I** – Proposed Plan of Study: Specify how you plan to fulfill each of the following requirements.

<table>
<thead>
<tr>
<th>Grand Challenge Problem:</th>
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<tbody>
<tr>
<td>Research/Creative Talent:</td>
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<tr>
<td>Multidisciplinarity:</td>
</tr>
<tr>
<td>Viable Business:</td>
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<tr>
<td>Multicultural:</td>
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<td>Social Consciousness:</td>
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**Connectivity:** Continuous enrollment in Grand Challenge Scholar Experience:
Participation in Grand Challenge Scholar in Residence events and peer mentor program

**Part II** – Explain in one to two pages (a) what you hope to accomplish through participation in the Grand Challenge Scholars Program and (b) how your plan of study relates to your specific Grand Challenge-like topic and will fulfill the performance criteria.