General Engineering Fall 2023

Creative Inquiry Project List

Creative Inquiry (CI) is the imaginative combination of engaged learning, cross-disciplinary interactions and undergraduate research that is unique to Clemson University. Team-based investigations are led by faculty mentors and typically span a year or more. Students take on problems that spring from their own curiosity, from a professor's challenge or from the pressing needs of the world around them. These invaluable experiences produce exceptional graduates.

The following list of CI projects in the College of Engineering, Computing, and Applied Sciences (CECAS) has been compiled for Fall 2023 General Engineering (GE) students. All projects on this list are appropriate for freshmen and new transfers. This list is comprised of several projects that are two or more semesters, meaning it can be continued once you have transitioned to your engineering major. Other projects may only last one or two semesters. Many of these CI projects are interdisciplinary and provide exposure to multiple fields of engineering (e.g., civil engineering, environmental engineering, electrical engineering, etc.). All CI's are 1 credit unless otherwise specified.

Projects #1 – 21 (pgs. 2-8) are open to any GE student. Project #22 (pg. 9) is only available to students in the Residents in Science and Engineering (RISE) Program. Projects with a "TBA" time, mean the faculty will work with students to decide on a meeting time. Information for each of the CI projects is presented as follows:

Project # | Title **Project Course Information**

Primary Faculty (*Faculty Dept./Program*)	Credits	Project Meeting Day and Time
Description of CI Project		

During orientation registration for Fall 2023 classes, interested students should register for the CI holding section (ENGR 1900-999, 1 credit hour). Engineering students are asked to submit their top three CI project choices via a Google Form that will be sent to their Clemson email address after their orientation session.

Please note: Students who register for the CI holding section MUST submit their project choices by 4 PM the day after their orientation session to remain enrolled in the ENGR 1900-999 holding section. Students who register for the holding section and do not submit their CI project choices via the Google Form will be dropped from the holding section. Students will be notified of their project placement via email. Please allow up to 7 business days for your class to update on your schedule.

Questions, please contact Ms. Monica Sint, GE Registration Coordinator, at **msint@clemson.edu**.

CI Projects for General Engineering Students

Project 1 | Biomedical Applications of Nanoparticles **MSE 3900-001**

Dr. O. Thompson Mefford (*Materials Science and Engineering*)		
Nanoparticles continue to be one of the fastest growing areas of interest in Materials Science. Due to design criteria, new synthetic techniques are needed to produce these particles with unique geometries. Students will focus on understanding the structure-property relationships of magnetic nanoparticles. Specifically the team will investigate how size and composition change the magnetic properties of these systems.		

Project 2 | Engineering Biology of Arthropods **MSE 3900-002**

Dr. Konstantin Kornev (*Materials Science and Engineering*)		
We explore structural and organismal features of insects from the physics and materials point of view looking at the physical determinants of the materials performance. The current project is focused on analysis of insect antennae as multifunctional fibers. The muscle-free antennae of insects demonstrate the behavior that surprise and challenge our assumptions about why and how muscle-free organs move and maneuver fast with a high precision and withstand extremely strong forces while keeping their functionality. There is an indication that insects control antennal movements by pumping blood through its lumen, as one would control a robotic arm by a hydraulic joystick. Considering that antenna is typically thinner than the human hair, the mechanisms that explain its millisecond reaction on perturbations are not clear. A team of students will study mechanisms of antenna bending and twisting, materials and transport properties of antennae and design and manufacture micro-joysticks for neurosurgical applications.		

Project 3 | Design Motility of Synthetic Cells **MSE 3900-007**

Dr. Kimberly Weirich (*Materials Science and Engineering*)		
The remarkable ability of cells to control shape, interact with their environment, and migrate directed through chemical and mechanical cues are some of the key features that set living systems apart from most synthetic systems. In this creative inquiry project, we will investigate minimal model cells, made from emulsion drops supported by a thin biological material shell. We will explore how stresses are mechanically stored and released in the biomaterial structure, resulting in emulsion drops that migrate! Research will investigate basic physical mechanisms of motility, elucidating how to control whether motion is sustained or intermittent and direction and speed in these minimal, bio-inspired, robot-like drops. Students from a variety of backgrounds are welcome to join and will gain experience in quantitative analysis and experimental techniques, and learn to be collaborative researchers as part of an interdisciplinary team.		

CI Projects for General Engineering Students

Project 4 | Biosystems Engineering CI Extravaganza **BE 1990-001**

Dr. Caye Drapcho (*Biosystems Engineering*)		Tuesday, 3:30-4:30
The course will be a survey of the following BE CI projects: H2 Biofuel, Arsenic Bioremediation, Oyster Reef/Mussel Restoration, Biosensing Tools, Biodiesel Production, and Algae C Capture.		

Project 5 | BioH2 Production **BE 4990-001**

Dr. Caye Drapcho (*Biosystems Engineering*)		Wednesday, 5-6:30
Learn hands-on laboratory techniques for cultivation of a natural thermophilic bacterium to produce hydrogen gas that can be captured as a biofuel.		

Project 6 | Oyster and Mussel Restoration **BE 4990-003**

Dr. Caye Drapcho (*Biosystems Engineering*)		Thursday, 5-6:30
85% of oyster reefs have been destroyed globally and many species of freshwater mussels are endangered/threatened. This team focuses on designing solutions for restoration.		

Project 7 | Biodiesel Production **BE 4990-005**

Dr. Tom Dodd (*Biosystems Engineering*)		Wednesday, 3-4
Biodiesel is a direct replacement for petroleum diesel. Learn the lab techniques and tour the pilot scale system for creating biodiesel.		

CI Projects for General Engineering Students

Project 8 | Cognitive Systems Engineering Research **IE 4040-011**

Dr. Sundeep Hegde (*Industrial Engineering*)		
The course will involve various stages and methods of human factors research, including literature reviews, study design, data collection, analysis and writing manuscripts. Potential areas will include healthcare system design, supporting adaptive capacity in organizations, and interface design.		

Project 9 | Healthcare Systems Analytics **IE 4040-111**

Dr. Sundeep Hegde (*Industrial Engineering*)		
Students will engage in ongoing projects in complex health-related domains such as emergency medicine and will gain training and experience in both qualitative (e.g. interviews) and quantitative (e.g. statistical analysis) research methods. Students will be involved in one or more stages of research, including observing/interviewing clinicians, data processing, analysis, and literature reviews. Previous coursework or experience in machine learning techniques is a plus, although not required.		

Project 10 | Robotic Systems Research **ECE 1990-001**

Dr. William J. Reid, Dr. Hassan Raza (*Electrical and Computer Engineering*)		
The team is to design and construct a robot which will compete in IEEE's Southeastcon conference hardware competition.		

Project 11 | Nanotechnology **ECE 1990-002**

Dr. Hassan Raza (*Electrical and Computer Engineering*)		
In this CI course, students will be introduced to the fundamentals and applications of Nanotechnology from Electrical and Computer Engineering (ECE) perspective. Nanotechnology is the art, science, and engineering of designing materials, devices, and systems at the nanoscale from bottom-up and/or top-down approaches. The role of this technology in ECE has been the driving force behind the information technology revolution over the past few decades and is further expected to be the enabling technology behind the next technological revolution in robotics, automation, and artificial intelligence. The course is structured around some introductory lectures, followed by student-driven research on a topic of student's choice. This CI experience may lead to publication of a review article, if a student takes the sequence over a few semesters.		

CI Projects for General Engineering Students

Project 12 | High-Performance Cluster Computing **ECE 1990-005**

Dr. Jon Cameron Calhoun (*Electrical and Computer Engineering*)		
Parallel computing is often a topic covered until the senior year for undergrads. Moreover, large-scale computing is becoming a fundamental tool to researchers in many fields of science and engineering (e.g., business, chemistry, physics, biology). This CI is dedicated to opening up parallel computing to all levels of undergrads in relevant fields of computational science and engineering. Through this CI, we explore how high-performance computing (HPC) systems impact various disciplines, how HPC systems are constructed, what it takes to program parallel applications, how to run parallel applications on an HPC system, and how to optimize applications.This CI is intended to introduce undergraduate students from various STEM disciplines to parallel computing early in their undergraduate experience. Skills and knowledge gained through hands on activities, research, and training will prepare students for undergraduate research, provide skills to help students stand out and succeed in graduate school, and provide students an opportunity to test their skills against teams from all over the world at the annual Supercomputing Conference's Student Cluster Competition.Each year the annual competition's scientific domain changes (e.g, geophysics, bioinformatics, molecular dynamics, hydrology, climate); therefore, this CI is open to STEM majors who can serve as domain scientists to help interpret scientific results produced by the HPC applications.		

Project 13 | Circuit Cellar **ECE 1990-006**

Dr. Hassan Raza, Dr. William J. Reid (*Electrical and Computer Engineering*)		
In this CI, students will have the opportunity to learn hands-on activities related to circuits and electronics based on integrated circuits (ICs) and discrete components. We will discuss various practical techniques complemented by simulations. Students may take this course sequence over multiple semesters to work on various aspects of hands-on skillset. Within the scope of this project-based learning, a student may work on a semester long project or on a project that spans over multiple semesters. Skillsets learned here include but are not limited to circuit analysis, electronics design techniques, PCB design and manufacturing, EDA tools, etc. We will conclude the semester by designing and implementing an electronic project based on the student's personal interest.		

CI Projects for General Engineering Students

Project 14 | Advanced Cyber Infrastructure **ECE 1990-007**

Dr. Kuang-Ching Wang (*Electrical and Computer Engineering*)		
The CI session currently focuses on conducting experimentation on National Science Foundation's FABRIC testbed. FABRIC is an NSF-funded Mid-scale Research Infrastructure project building the world's most advanced Internet testbed that spans the US and countries in Europe, Asia, and South America. The Internet testbed enables students and researchers to create Internet-scale applications and network solutions for future technologies in areas such as AI, security, high energy physics, astronomy, climate modeling, Internet of Things, robotics, and more. The CI team is now recruiting the most talented undergraduate students who are passionate in learning, and helping others to learn, to create applications on this testbed. The interns will work with a national team to conduct experiments on FABRIC as early users, participate in FABRIC early experiment planning, execution, and demos, and support development of learning modules for new FABRIC users. CI team members will develop sample Jupyter Notebooks showing how to use basic building blocks of FABRIC. These activities will develop research skills for the students in a way that will blend their research experience into the FABRIC project's development, testing, early user experiment enablement, troubleshooting, and documentation and demo tasks. Outstanding CI team members will be recruited as NSF REU interns (paid position).		

Project 15 | Robot Networks **ECE 1990-014**

Dr. Yongqiang Wang (*Electrical and Computer Engineering*)		
The technological development of the last decade in robots, computing and communications has led to envisage the design of robotic and automation systems consisting of networked vehicles, sensors, actuators and communication devices. These developments enable researchers and engineers to design new robotic systems that can interact with human beings and other robots in a cooperative way. Applications span surveillance/monitoring, manufacturing, intelligent vehicles, exploration, and many others. In this project, we will explore some basics of robot networks and build robotic cooperation using several intelligent ground robots available in the lab. No knowledge of distributed dynamical systems or robotics is needed.		

CI Projects for General Engineering Students

Project 16 | Videogame Development **ECE 1990-015**

Dr. Yongqiang Wang (*Electrical and Computer Engineering*)		
This project aims at the development of a car racing video game which can enhance the student learning experience of distributed dynamical systems and intelligent transportation systems. The project will be built upon existing work which already realized a sophisticated vehicle simulator, a game framework, and graphics engine. Students will be focused on developing an interface between existing work and student learning process. The game development itself will be a fun learning process. Knowledge of Linux and C++/C is preferred but not required. No knowledge of distributed dynamical systems is needed.		

Project 17 | Videogame Development (HON) **ECE 1990-016**

Dr. Yongqiang Wang (*Electrical and Computer Engineering*)		
This project aims at the development of a car racing video game which can enhance the student learning experience of distributed dynamical systems and intelligent transportation systems. The project will be built upon existing work which already realized a sophisticated vehicle simulator, a game framework, and graphics engine. Students will be focused on developing an interface between existing work and student learning process. The game development itself will be a fun learning process. Knowledge of Linux and C++/C is preferred but not required. No knowledge of distributed dynamical systems is needed.		

Project 18 | Deep Learning and Big Data **ECE 1990-018**

Dr. Melissa C Smith (*Electrical and Computer Engineering*)		
Machine Learning is a field which is becoming increasingly useful in a wide variety of domains due to the accumulation of large amounts of raw data ("big data") and the availability of high-performance computing (HPC) systems which can process this data. These domains include image processing, natural language processing, autonomous driving, gene set analysis, molecular structure classification, and many others. The goal of this Creative Inquiry is to equip students with the various skills required to apply machine learning techniques to real-world problems, which includes data-related issues such as how to select and load a dataset, software-related issues such as how to implement a machine learning pipeline from basic components, and hardware-related issues such as how to best take advantage of GPUs and other high-performance computing resources. Students will gain hands-on experience with machine learning / big data by working on a real-world problem of their choice.		

CI Projects for General Engineering Students

Project 19 | Advanced Manufacturing by Ultrafast Lasers **ME 2900-037**

Dr. Xin Zhao (*Mechanical Engineering*)		
Due to the significant advances of lasers, laser-based manufacturing and material processing have been widely used in many industry sectors, including energy, automotive, electronics, bioengineering, medicine, aerospace/aeronautics, etc. Ultrafast lasers are one of the most advanced laser machines which offer extremely high laser intensity, short pulse duration, and introduce ultrafast phenomena during laser-matter interaction. It is an ideal tool for high precision manufacturing processes of materials which are difficult to be processed by traditional methods. This project aims to understand the fundamentals of ultrafast lasers and laser-matter interaction, and explore its applications in micromachining, material strengthening, and multi-functional surface processing. This project includes hands-on participation to learn the state-of-the-art ultrafast laser and use it for micro-manufacturing, material strengthening, and multi-functional surface processing. The project length is expected to be 2 semesters.		

Project 20 | Water Quality Monitoring **EES 4900-011**

Dr. David A. Ladner *(Environmental Engineering)*		Tuesday, 3:30-4:45
The Water Quality Monitoring team interfaces with the South Carolina Adopt-a-Stream (AAS) program. Students become trained, certified AAS volunteers and perform field work to measure temperature, pH, dissolved oxygen, clarity, and other water quality parameters. The measured data are entered into the AAS database to provide baseline water quality data for the state. Then, our team takes things to another level by finding additional monitoring sites, performing data analysis on the statewide AAS database using machine learning tools, and measuring additional water quality parameters like nitrate, which is a strong indicator of wastewater exposure in natural streams. A current goal is to evaluate AAS data alongside drinking water treatment plant data to explore the predictive power of the citizen-science data set.		

Project 21 | Microfluidics and Lab-on-a-chip **ENGR 1900-031**

Dr. Xiangchun Xuan (*Mechanical Engineering*)		
In this Creative Inquiry project, we explore the use of electric, magnetic or flow field for the transport and control of biological and synthetic particles in engineered microchannels with lab-on-a-chip applications to chemistry and biomedicine for point of care technology.		

RISE CI Projects

The following projects are restricted to students who are participating in the Residents in Science and Engineering (RISE) program.

Project 22 | Green Roofs, Rainwater Cisterns, and Urban Agriculture **ENGR 1900 – 024**

Dr. Will Martin (*General Engineering*)	2 + Semesters – 1 credit	

This project is exploring the possible synergy between utilizing green roofs, rainwater cisterns, and roof top agriculture. Green roofs have many benefits, but their impact on reducing stormwater runoff quantity from larger design storms is limited. Including a cistern can be a way to improve this, a cistern by itself is not a reasonable approach if there is no use for the stored water. Urban agriculture is the link that we will use to couple these two BMPs as the stored water can be used to irrigate the plants in the green roof, which expands the types of plants which can be grown to crops which can be harvested and produce a source of revenue as well as a source of locally produced food.