Department:	**Biology & Biotechnology**
Project title:	**Defining functional complexes of the retinoblastoma tumor suppressor protein**
Faculty name:	**Amity Manning**
Short project description:	Students working on this project will use biochemical and cell biological approaches to identify protein complexes that contain the retinoblastoma tumor suppressor protein (pRB).
Full project description:	The retinoblastoma protein (pRB) has a critical tumor suppressive function during early stages of the cell cycle to limit proliferation. Evidence suggests that pRB has other important roles in DNA damage response and chromatin regulation at later stages of the cell cycle. This project will use a human cell line that has been genetically engineered to express pRB fused to an enzyme that can mark nearby proteins with a chemical modification. Using molecular, cell biological, and biochemical approaches to first mark and then track proteins that bind to pRB, this project will identify distinct protein complexes that pRB forms during early and late stages of the cell cycle and in response to DNA damage.
Skills to gain:	This project will expose the student to mammalian cell culture techniques (ie: cell line generation and maintenance; antibiotic selection and drug response), biochemical approaches to identify protein-protein interactions (ie covalent labeling of proteins, immuno-precipitation protein complex purification) and protein analysis (ie bradford assays and western blots).
Accepted majors:	BBT, CBC, BCB, BME
A project for:	Rising sophomore, or Rising junior, or A student with some research experience
Prerequisites:	BB1035 intro to Biotechnology and/or BB2550 cell biology and/or BB2950 Molecular Biology
Mentoring plan for the undergraduate student:	The student/pair of students will meet at least weekly with me to go over experimental approach and rational and will then work closely on a day to day basis with a graduate student to learn and apply the experimental techniques. The student/pair of students will also attend weekly lab meetings where they will hear about the experimental progress of related work in the lab and participate in "journal club" style discussion of recently published work that is relevant to my lab's research interests.

Department:	**Biology & Biotechnology**
Project title:	**Investigating sex differences in Alzheimer's disease presentation**
Faculty name:	**Jagan Srinivasan**
Short project description:	Alzheimer's disease has a sex bias and we will explore sex bias in Alzheimer's disease by measuring sex-specific behavioral differences in Alzheimer's disease model Caenorhabditis elegans.
Full project description:	Alzheimer's disease is a neurodegenerative disease that causes progressive loss of cognitive function. For reasons as yet unknown, women develop Alzheimer's disease at a higher rate than men. This observation has led researchers to investigate sex-specific differences within the brain may be involved in Alzheimer's disease pathology. We will be studying the sex-bias in Alzheimer's disease using Caenorhabditis elegans (a small, transparent worm). This worm has two sexes, Hermaphrodite (self-fertilizing female) and male. We ask: do male and hermaphrodite worms show different responses to same cue when they have Alzheimer's disease (AD)? Using a worm model of AD, we will investigate responses to olfactory cues as AD causes decreased olfactory discrimination. Using behavioral assays, we will test responses to a variety of attractive and repulsive olfactory cues. These assays will allow us to establish if one sex loses more sensory discrimination than the other upon Alzheimer's disease onset.
Skills to gain:	The student will gain on generating a hypothesis and coming up with an experimental methodology. The student will be able to test the hypothesis using the experimental design and come up with a suitable interpretation of his data. The student will then present and share his data with the lab in the form of a poster presentation and get feedback on the data generated.
Accepted majors:	CBC, ChE, BBT, EE
A project for:	Rising sophomore, or Rising junior, or A student with minimal/no research experience, or A student with some research experience
Prerequisites:	None
Mentoring plan for the undergraduate student:	The goal of the research mentoring plan will be to provide the skills, knowledge and experience to prepare and introduce the undergrad to the path of scientific discovery. The proposed project will involve direct interactions between the student, myself and a senior graduate student Caroline Muirhead. Detailed below is the detailed structured set of goals: 1. Lab and topic Orientation: in-depth conversations between advisor, student and graduate student to establish and implement an Individual Undergrad Development Plan. Orientation topics will include (a) work habits and laboratory safety, (b) interaction with coworkers, (c) introduction to the model system and documentation of research methodologies. 2. In addition, the student will: a. Learn and document new techniques; b. Participate at Lab meeting presentations to learn about effective presentation skills; c. Have one -on one session focused on building skills in the communication of research. Other students in the lab will give feedback on the student's presentation; d. One-on-one meetings to review progress; e. Interact with students from other worm labs on the floor to gain additional insights in C. elegans and to appreciate the breadth of research topics.

Department:	**Biology & Biotechnology**
Project title:	**The role of Girdin in motor neuron development and synaptogenesis**
Faculty name:	**Inna Nechipurenko**
Short project description:	A student will learn fundamentals of Drosophila (fruit fly) genetics, immunofluorescence, and high-resolution confocal microscopy to investigate motor neuron differentiation and synaptic development in girdin mutants.
Full project description:	The girdin gene encodes a multidomain protein that is highly conserved across evolution. Human GIRDIN is broadly expressed in the brain, and mutations in the GIRDIN gene have been identified in patients with a rare neurodegenerative disorder (PEHO syndrome), thus highlighting the importance of GIRDIN in neuronal function. A recent study has demonstrated that Girdin modulates synaptic plasticity in adult hippocampal neurons; however, its roles in synaptic development have not been explored. Using the fruit fly Drosophila melanogaster as our experimental model, we will design a series of experiments to determine the extent to which Girdin regulates synaptogenesis and activity-dependent synaptic remodeling during development. Drosophila Girdin is highly expressed in the developing nervous system, including motor neurons, which form synapses (neuromuscular junctions or NMJs) with body wall muscles. An EREE student will use immunofluorescence and high-resolution confocal microscopy to 1) evaluate motor axon pathfinding toward specific muscle targets and 2) assess gross NMJ architecture and activity-dependent synaptic refinement during NMJ development in control (wild-type) and girdin mutant flies at relevant developmental stages.
Skills to gain:	The student working on this project will apply the scientific method to formulate and rigorously test a working hypothesis. In the course of this project, the student will acquire the following skills/concepts: 1) basic Drosophila genetics, 2) principles of the immunofluorescence technique, 3) basic concepts of optical microscopy, and 4) data analysis, including selecting an appropriate statistical method to test hypotheses.
Accepted majors:	BB, BCh, BME
A project for:	Rising sophomore, or Rising junior
Prerequisites:	BB1035 Introduction to Biotechnology OR BB2920 Genetics OR BB2550 Cell Biology OR BB3080 Neurobiology
Mentoring plan for the undergraduate student:	For the duration of this project, the student will have a designated lab bench in my lab. I will provide the student with the necessary conceptual framework to design experiments and carry out genetic crosses. A graduate student (Christina Campagna) and a research associate (Hayley McMahon) will be available to assist the EREE student with experiments and/or answer project-related questions on a daily basis. In addition, I will meet with the student regularly (once per week) to discuss progress, map out experiments, and assist with data analysis. The student will have the opportunity to participate in lab group meetings and discuss his/her/their research findings with other members of my research group.

Department:	**Biology & Biotechnology**
Project title:	**Identifying enzymes that control RNA degradation and stress tolerance in bacteria**
Faculty name:	**Scarlet Shell**
Short project description:	Students working on this project with investigate the mechanisms that pathogenic bacteria use to survive stressful conditions.
Full project description:	Tuberculosis, caused by the bacterium Mycobacterium tuberculosis, kills 1.4 million people each year. These infections are difficult to cure with antibiotics because the bacteria have a variety of stress-tolerance mechanisms that allow them to survive antibiotics and other stressors. One of the ways bacteria respond to stress is by changing their rates of mRNA synthesis and degradation. However, in many cases we do not understand how they do this. In summer 2022, we invite 1-2 EREE students to join our team and help us identify enzymes that bacteria use to protect or degrade their mRNA. The students will use the non-pathogenic model organism Mycolicibacterium smegmatis, which can be handled safely and genetically manipulated easily. The students will genetically modify M. smegmatis by deleting putative mRNA-modifying enzymes from its genome. They will then determine the impact of these mutations on growth rate, mRNA degradation rates, and stress tolerance. The resulting data will help us understand how mycobacteria regulate their RNA metabolism, as well as the relationship between RNA metabolism and stress tolerance.
Skills to gain:	The students will learn a variety of molecular biology, genetic engineering, and microbiology skills. Specifically, they will learn how to design plasmids and primers, use PCR and molecular cloning to make plasmids, culture E. coli and mycobacteria, use state-of-the-art methods to genetically modify mycobacterial genomes, measure mRNA degradation rates by quantitative PCR, and measure bacterial growth kinetics and stress tolerance. In the process, the students will also learn how to design experiments with proper controls, troubleshoot failed experiments, use statistical analysis software to analyze their data, and interpret their data. The students will also further their professional development by learning how to read primary literature, contextualizing their research question within the field, presenting their experiments and data in lab meeting, and working within an externally funded research lab where projects are driven largely by graduate students and postdocs.
Accepted majors:	BBT, BCh, BCB, BME
A project for:	Rising sophomore, or Rising junior, or A student with minimal/no research experience, or A student with some research experience
Prerequisites:	The students need to have taken at least one biology lab course, at least one chemistry course with a lab, and have taken BB1035 (Biotechnology) or obtained equivalent knowledge elsewhere. Taking BB2950 (Molecular Biology) is not absolutely necessary but is strongly preferred.
Mentoring plan for the undergraduate student:	I will introduce the students to their project and place it into the context of the other projects ongoing in the lab and the field more broadly. I will meet with the students at least once a week to discuss their experiments and progress and help with troubleshooting and data interpretation and contextualization. My PhD students Julia Ryan and Abby Rapiejko and my postdocs Natalia Alonso and Hilario Cafiero will provide daily mentoring to the students in the lab. Most of the projects in the lab are interrelated and most lab members regularly perform core techniques such as PCR, cloning, mycobacterial culture, and quantitative PCR. We therefore have a lab culture in which all of the senior lab members are available on an as-needed basis to help and advise undergraduates. I will provide students with journal articles related to their project and meet with them to discuss the articles and how they relate to our work. We have weekly lab meetings in which lab members take turns presenting their data and relevant articles from the primary literature. Students will attend lab meeting weekly and present their own project at the end of their research experience. Students will have the opportunity to attend a regional conference in June.

Department:	**Biomedical Engineering**
Project title:	**Mechanical testing to simulate running biomechanics in the metatarsals**
Faculty name:	**Karen Troy**
Short project description:	Students working on this project will be challenged to investigate how damage accumulates in the bones of the feet during running.
Full project description:	Students will conduct mechanical fatigue testing on metatarsal bones from cadaveric specimens. This project will involve imaging cadaveric feet, dissection and specimen preparation, and using the Instron materials testing machine to load the bones in physiologically relevant conditions. The goal is to compare the effect of axial versus combination (axial+bending) forces on bone fatigue, and to examine the effect of stress magnitude on fatigue life. Depending on student interest and skills, students may pursue sub-questions that rely on techniques such as medical imaging and quantitative image analysis, histology and microscopy, and stress/strain calculations.
Skills to gain:	Students would get hands-on skills with anatomy, biosafety and dissection, mechanical testing, statistical analysis, medical imaging, and image analysis. They would read research literature on the topic of bone stress injuries and running biomechanics, and be exposed to the broader world of clinical biomechanics and biomedical engineering. They would have the ability to assist in other types of data that are being collected in the lab by other students, such as motion capture.
Accepted majors:	BME, ME
A project for:	Rising junior, or A student with minimal/no research experience, or A student with some research experience
Prerequisites:	Stress: ES 2502 OR ME 3501. Experience with mechanical testing would be helpful. E.g. BME 3505. BME 3506, ME3901 or ME 3902 .
Mentoring plan for the undergraduate student:	Our group has biweekly lab meetings and biweekly individual meetings. The undergraduate student would be expected to participate in each of these. Additionally, our group meets weekly for either a journal club or another professional development activity, which the student would participate in. Finally, the student would be paired with two graduate student mentors: Andrew Wilzman and Bryhannah Young. Andrew is a 2nd year PhD student who is experienced with many techniques and can serve as a resource to the student. Bryhannah is a first year Master's Student, and is also an underrepresented minority. Bryhannah has a Career Development Plan that we created as part of a funded NIH Diversity Supplement, which includes gaining experience mentoring and working with younger students. As part of this Plan, I will be meeting weekly with Bryhannah to make sure she and the undergraduate student feel well supported. At the start of the summer, each student complete a "goals" worksheet that includes scientific, personal, and writing goals. I will do this for the undergraduate student too. As a mentor, I ask myself how I can most effectively help my students achieve their goals (versus asking how they can achieve MY goals).

Department:	**Biomedical Engineering**
Project title:	**Development and testing of a new nematode traumatic brain injury (TBI) model**
Faculty name:	**Dirk Albrecht**
Short project description:	Students working on this project will refine and test a blast overpressure injury model as a repeatable form of traumatic brain injury (TBI) and assess how various injury parameters (magnitude, duration, frequency) affect live brain activity and behavior in the C. elegans model.
Full project description:	How mild traumatic brain injury (TBI) affects neural function is currently unknown. Students will collect data on spontaneous and stimulus-evoked behavioral and neural responses of C. elegans to varying levels of mechanical injury by blast overpressure. These experiments use microfluidic devices for precise environmental control and will analyze conditions that lead to the physiologic changes consistent with traumatic brain injury. These microfluidic devices are so small that the "blasts" are air puffs without danger to researchers or equipment! Live brain activity is recorded using microscopy and optogenetic reagents already established in the lab. The results of this project will inform future work in studying effects of injury timing and magnitude, neuroprotective processes and therapies, and the genes and biochemical pathways that affect neural responses following mechanical injury. Students have the opportunity to learn many practical skills, including microfluidics, microscopy, lab automation, and data analysis.
Skills to gain:	The student will learn nematode culture, microfluidics, lab automation, microscopy, image processing, and data analysis.
Accepted majors:	BME, BBT, ME, RBE, PH
A project for:	Rising sophomore, or Rising junior, or A student with minimal/no research experience, or A student with some research experience
Prerequisites:	None, but familiarity with basic wet lab skills use of programming environments (e.g., MATLAB) are useful.
Mentoring plan for the undergraduate student:	The student will join as a full lab member, including daily interaction with the mentoring graduate student and weekly lab meetings and PI interaction, as needed. The student will be encouraged to present results in a lab meeting and externally, either in the Undergraduate Research event or an external research conference (such as BMES).

Department:	**Biomedical Engineering**
Project title:	**Testing a Deep Brain Stimulation (DBS) device to alter neural and behavioral responses in a nematode model**
Faculty name:	**Dirk Albrecht**
Short project description:	This project will test a new electrical stimulation system, determine parameters that increase and decrease neural responses, and assess resulting behavioral effects in normal C. elegans and a model of Parkinson's disease.
Full project description:	Deep Brain Stimulation is an effective tool to restore neural function in patients with neurological disorders. Currently, stimulation parameters such as frequency, pulse duration, voltage, and polarity are determined empirically for each patient, and mechanisms of action are not well understood. This project aims to systematically evaluate parameters that increase or decrease neural activity, using a recent MQP project capable of delivering precise electrical stimulation to C. elegans contained within microfluidic devices. Expanding on prior results, the student will run DBS stimulation experiments with a wide range of frequencies, duty cycles and stimulation voltages using the power supply and electronic equipment provided. Live brain activity is obtained by microscopy, and data will then be analyzed using existing methods to determine neural responses under a variety of conditions. A successful project will identify DBS parameters that alter live neural activity under normal conditions. Extended experiments would examine the effect of DBS on a Parkinson's disease model, both neural activity and locomotory behavior.
Skills to gain:	The student will learn nematode culture, microfluidics, lab automation, microscopy, image processing, and data analysis.
Accepted majors:	BME, ECE, ME, RBE, BBT, PH
A project for:	Rising sophomore, or Rising junior, or A student with minimal/no research experience, or A student with some research experience
Prerequisites:	None, although helpful background includes circuits (BME2210 or ECE2010), some familiarity with basic wet lab skills and use of programming environments (such as MATLAB, ImageJ).
Mentoring plan for the undergraduate student:	The student will join as a full lab member, including daily interaction with the mentoring graduate student and weekly lab meetings and PI interaction, as needed. The student will be encouraged to present results in a lab meeting and externally, either in the Undergraduate Research event or an external research conference (such as BMES).

Department:	**Biomedical Engineering**
Project title:	**Development of combined shear stress and stretch device to condition human endothelial cells**
Faculty name:	**Solomon Mensah**
Short project description:	The flow of blood in blood vessels, introduce a combination of mechanical forces to endothelial cells(cells that line the luminal side of blood vessels). We want to develop a system that can introduce a combination of shear stress and stretch forces to endothelial cells.
Full project description:	The purpose of this project is to develop a novel bioreactor that combines the simulation of both stretching and shear stress that occurs in human microvascular system to endothelial cells in vitro. There are already functioning bioreactors that can replicate either stretching or shear stress, but few devices exist that can apply a combinatory effect of shear and stretch on human endothelial cells. The purpose for the development of this novel bioreactor is to determine the effect of shear stress and stretch on endothelial cell glycocalyx. Students will develop and test a bioreactor and use the reactor to condition human lung microvascular endothelial cells. Students will be required to conduct in vitro experiments which include flow simulations, cell culture, immunostaining, imaging, and data analysis.
Skills to gain:	Product Development, Antibody immunostaining, Cell culture, Imaging, Data Analysis
Accepted majors:	ME, BB, CH, BME
A project for:	Rising sophomore, or Rising junior, or A student with minimal/no research experience, or A student with some research experience
Prerequisites:	None
Mentoring plan for the undergraduate student:	In the first week, the prospective student will be oriented in basic lab practices and aseptic methods. This will be followed by a brief lecture on product development and needs assessment by faculty. In subsequent weeks, the student will be orientated on basic cell culture and immunostaining protocols by faculty. The student will then be paired with a graduate student who will be working directly with the student to understand the scope of the project and the requirement. There will be weekly meetings to assess student performance and progress on the project.

Department:	**Biomedical Engineering**
Project title:	**Investigating the biomechanical mechanisms of Calcific Aortic Valve Disease**
Faculty name:	**Kristen Billiar**
Short project description:	This project involves analysis of how mechanical forces regulate Calcific Aortic Valve Disease using tissue engineering models, cell culture, and quantitative image analysis.
Full project description:	Programmed cell death, or apoptosis, is a part of the cell's life cycle. During this procedure, cells divide into smaller vesicles which are consumed by nearby cells or cleaned up by the immune system. Even though there are multiple ways to clear the apoptotic bodies, some of them are not removed. These remnants later may cause unwanted changes, like calcification. The goal of this project is to investigate the calcification of valvular interstitial cells in 3D aggregate models being developed in our lab under both static and dynamically loaded conditions. This work will improve our understanding of the relation between mechanical forces and calcification.
Skills to gain:	The student will become proficient in cell culture, learn to create multi-cell spheroids, stain cells, image cells with microscope, and analyze digital images quantitatively.
Accepted majors:	BME
A project for:	Rising sophomore, or Rising junior, or A student with minimal/no research experience, or A student with some research experience
Prerequisites:	None, but stress analysis/mechanics, cell biology, cell engineering lab and image analysis (ImageJ) experience preferred.
Mentoring plan for the undergraduate student:	Each undergraduate who works in our lab is mentored by a graduate student. They develop a mentor-mentee contract (project description, time expectations, how they'll communicate, etc.). All trainees (from postdoc to high school) attend weekly lab meetings which consist of discussion of lab issues, data presentation, and journal club. J-club presentations rotate between all lab members.

Department:	**Biomedical Engineering**
Project title:	**Evaluating the Impact of Photoinitators on Mammalian Cell Death**
Faculty name:	**Catherine Whittington**
Short project description:	Students working on this project will perform cell culture and use cell analysis techniques to investigate whether photoinitiators that we use to stiffen collagen materials are toxic to the mouse and human cell lines we use in our models of tumors and lymphatic vessels.
Full project description:	Our lab plans to use light to stiffen collagen to mimic stiffening that occurs in body tissues during disease progression (e.g., pancreatic tumors). Photoinitiators are added to collagen and when both are exposed to light, the collagen stiffens in a process is called photo-crosslinking. Various studies have been performed to determine whether photoinitiators are toxic to cells in experiments, but results are mixed and some photoinitators have been studied more than others. Toxicity also appears to be dependent on the cell type used. The EREE project will evaluate the toxicity of up to three photoinitators commonly used in collagen photo-crosslinking on pancreatic cancer cell lines that we use for tumor modeling. Cells within collagen will be exposed to photoinitiators with and without light and with different light exposure routines (pulsed vs sustained light). Measured outputs will be cell growth, cell death, cell shape, collagen stiffness, and collagen degradation. Students will learn laboratory skills related to: mechanical testing of soft materials, material degradation, image capture using a microscope, image analysis, cell culture. data analysis, basic statistics, and data presentation. No prior experience is required.
Skills to gain:	Student will learn laboratory skills related to: mechanical testing of soft materials, material degradation, image capture using a microscope, image analysis, cell culture. data analysis, basic statistics, and data presentation. The student will also learn how to read and critically asses primary research and review articles. No prior experience is required.
Accepted majors:	BME, ChE, ME, BBT, PH, CH, BCh (any major who is interested in the work)
A project for:	Rising sophomore, or Rising junior, or A student with minimal/no research experience, or A student with some research experience
Prerequisites:	None
Mentoring plan for the undergraduate student:	The EREE student will be mentored by a 3nd year PhD student in my research laboratory under my supervision. The EREE student, graduate student, and I will meet at the start of the program to discuss mentorship and expectations for the summer. The three of us will also have regular meetings to monitor progress, give feedback, troubleshoot experiments, etc., and all students are involved in regular group meetings with all research students. The EREE student will also be included in all research group activities, including social activities. I will ensure that they have their own project that integrates with an existing project in the research program. The EREE student will start the program by completing all necessary training to work safely in the research laboratory prior to being trained on project-specific skills. Our laboratory space is open concept, which fosters a collaborative environment, so the EREE student will be introduced to other researchers who work in other research groups. I also work to ensure that I am available to all of my trainees by email, Slack, or one-on-one meetings. Throughout the summer, we will make adjustments as needed to help the student have the best possible overall experience.

Department:	**Biomedical Engineering**
Project title:	**Effects of Collagen Stiffening on Lymphatic Vessel Sprouting**
Faculty name:	**Catherine Whittington**
Short project description:	Students working on this project will perform cell culture and use cell analysis techniques to investigate how collagen matrix stiffening effects lymphatic vessel sprouting in microfluidic chips used to model lymphatic disorders.
Full project description:	Lymphatic vessels are important for several different functions in the body, and when they are dysfunctional or sparse, the body cannot perform certain functions. In disease, the tissue around the vessels is altered, and we want to know how tissue stiffness affects the vessels. Since the majority of lymphatic vessel research uses microfluidic chips, we have fabricated microfluidic chips that can hold collagen and cells. Collagen is used, because it is a major component of our body's tissues, and its stiffness is significantly altered in disease. For EREE, collagen will be injected around channels in the microfluidic chip, and lymphatic cells line the channels. Over time, lymphatic cells will grow/sprout into the collagen, and we will observe how vessel growth/sprouting changes as collagen stiffens over time. Measured outcomes will include vessel length, diameter, and integrity, collagen stiffness, and collagen degradation. Students will learn laboratory skills related to: microfluidic chip fabrication, mechanical testing of soft materials, image capture (microscope) and analysis, cell culture, data analysis, basic statistics, and data presentation. No prior experience is required.
Skills to gain:	Students will learn laboratory skills related to: microfluidic chip fabrication, mechanical testing of soft materials, image capture (microscope) and analysis, cell culture, data analysis, basic statistics, and data presentation. The student will also learn how to read and critically assess primary research and review articles. No prior experience is required.
Accepted majors:	BME, ChE, ME, BBT, PH, CH, BCh (any major who is interested in the work)
A project for:	Rising sophomore, or Rising junior, or A student with minimal/no research experience, or A student with some research experience
Prerequisites:	None
Mentoring plan for the undergraduate student:	The EREE student will be mentored by a 3nd year PhD student in my research laboratory under my supervision. The EREE student, graduate student, and I will meet at the start of the program to discuss mentorship and expectations for the summer. The three of us will also have regular meetings to monitor progress, give feedback, troubleshoot experiments, etc., and all students are involved in regular group meetings with all research students. The EREE student will also be included in all research group activities, including social activities. I will ensure that they have their own project that integrates with an existing project in the research program. The EREE student will start the program by completing all necessary training to work safely in the research laboratory prior to being trained on project-specific skills. Our laboratory space is open concept, which fosters a collaborative environment, so the EREE student will be introduced to other researchers who work in other research groups. I also work to ensure that I am available to all of my trainees by email, Slack, or one-on-one meetings. Throughout the summer, we will make adjustments as needed to help the student have the best possible overall experience.

Department:	**Biomedical Engineering (WPI); Radiology (University of Massachusetts Chan Medical School)**
Project title:	**Deep Learning-Based Real-Time Vascular Anatomy Assessment Tool for Emergency Stroke Interventions**
Faculty name:	**Mohammed Salman Shazeeb**
Short project description:	Students working on this project will be involved with a multi-disciplinary team at UMASS Chan Medical School to learn about the application of artificial intelligence/deep learing methods in the field of medical imaging to enhance emergency stroke interventions in the clinic
Full project description:	Annually in the United States, 795,000 people suffer from stroke causing 140,000 deaths. Most of these strokes are ischemic, meaning that a blood vessel to the brain is occluded by a clot. Physicians use mechanical thrombectomy, which is an endovascular procedure requiring the navigation of intraarterial catheter devices from a peripheral puncture through winding arterial pathways to the affected part of the brain to remove the clot. Physicians are limited to scrolling through 2D computed tomography angiography (CTA) images to examine a patient's anatomy, judge its complexity, and then select a catheter setup. Research in fast and accurate methods for analyzing human anatomy in medical images, including segmentation and 3D reconstruction, has experienced an explosive growth thanks to deep learning advances using powerful computing resources, which creates outputs in fractions of a second, making real-time results available to physicians. We propose to develop a model to perform complex analysis of the arterial pathway using patients' 2D CTA images to generate 3D models. This tool will aid the decision-making process in emergency settings saving time to recanalization, reducing operator uncertainty, and improving patient outcomes.
Skills to gain:	The student will gain an understanding of the basics of deep learning and its application in the field of medical imaging. Skills related to segmentations, reconstructions, image analysis, and programming will be acquired catering to the student's level of experience. Regardless of experience, the student will be able to find a fit in this project and learn as much as possible in the different aspects of applying deep learning methods to a clinical setting.
Accepted majors:	BME, EE, CS, BB, PH, MA
A project for:	Rising sophomore, or Rising junior, or A student with minimal/no research experience, or A student with some research experience
Prerequisites:	None
Mentoring plan for the undergraduate student:	Upon acceptance, I will introduce the student to my research group at UMASS Chan Medical School and setup him/her up with the necessary tools needed to complete the project. This position would require occasional visits to the UMASS medical campus but most of the job can be done remotely. We will provide the adequate training needed in order to complete the project. Along with my research team, I would meet with the student a few times weekly to ensure that the tasks are being completed on time. Depending on the student's experience, we have the flexibility of giving him/her more complex tasks related to the project. This will be determined as we progress with the project and on the student's performance.

Department:	**Chemical Engineering**
Project title:	**Conversion of Wastes into Fuels, Chemicals, and Materials**
Faculty name:	**Michael Timko**
Short project description:	Students will work on an exciting project to convert wastes into useful products, thereby solving environmental problems by creating value.
Full project description:	The project area is conversion of wastes into useful products, and there are several paths that students can select. For example, my group has continuing interest in conversion of food waste into transportation fuels; new projects on converting sewage sludge into renewable natural gas; and solid waste into water purification adsorbents. Our methods involve thermal reactions and catalysis. A major emphasis is on connecting applications to fundamental chemical and engineering principles. Students will learn a range of skills for running reactions and analyzing their products; the group holds weekly meetings to learn about what everyone else is doing. The environment is collaborative and supportive, and we have access to a range of reaction and analysis tools. A successful summer project can easily transform into on-going research during the academic year, future summers, and as part of an MQP. Previous students in the group have gone on to successful careers in engineering design, biopharma, and graduate school.
Skills to gain:	The student will learn reaction and product analysis skills, including how to perform kinetic studies, prepare and analyze catalysts, and characterize complex product mixtures using spectroscopy and chromatography tools. The student will learn to work in a collaborative team environment, where they are supported by their teammates while contributing to a broader vision. Regular meetings will be used to teach the student data analysis, processing, and visualization skills. The student will present their work to the group to develop oral presentation skills and my hope is that the student will participate in writing up their work for publication in the peer-reviewed literature.
Accepted majors:	ChE, EVE, CH, ME
A project for:	Rising sophomore, or Rising junior, or A student with minimal/no research experience, or A student with some research experience
Prerequisites:	None
Mentoring plan for the undergraduate student:	My group has a long history of successful undergraduate student mentoring, with former students leading successful careers in industry and graduate school. Two former students are recipients of the NSF GRF and former students are attending or have graduated from many of the top PhD programs in the U.S., including Minnesota, UCSB, Wisconsin, Columbia, and others. We have developed and refined a hierarchical mentoring plan that provides both day-to-day and long-range advisement. Specifically, senior graduate students or post-docs provide a regular, near-peer mentor for incoming students. The match is made based primarily on the technical content of the project, and takes into consideration many other factors such as age, gender, etc. The near-peer mentor trains the student in day-to-day skills, such as how to safely run reactions and analyze products. As group PI, I meet regularly with the student and their near-peer mentors to provide longer range advisement, in skills that include hypothesis development and testing, resource allocation, data analysis, and similar. In addition, the entire group is designed to provide informal mentoring and role models for younger students. We strive to be a team, in every sense.

Department:	**Chemical Engineering**
Project title:	**Liposome development for pharmaceutical transport screening during pregnancy**
Faculty name:	**Christina Bailey-Hytholt**
Short project description:	Students working on this project will learn how to formulate liposomes using microfluidic mixing to develop a screening tool for small molecule transport at the maternal-fetal interface.
Full project description:	The placenta plays an important role during pregnancy, yet it remains one of the least understood human organs. The main cell type composing the placenta, trophoblast cells, have important functions, including nutrient and waste transport. These placental trophoblast cells have great potential for use in developing biomimetic models of the maternal-fetal interface. Current models for understanding placental transport are limited. Our goal is to develop cell-free models of the placenta to provide highly useful tools for enabling initial screening studies. By using bioengineering approaches, we aim to develop placental proteoliposomes to facilitate active transport screening of a wide range of pharmaceuticals by incorporating key transmembrane proteins that have been identified as important components for placental transport. To formulate the proteoliposomes we will use a microfluidic mixing platform to produce liposomes with uniform size distributions, low polydispersity, and batch to batch reproducibility. The proteoliposomes will also allow for understanding of how pharmaceuticals may impact nutrient transport. Overall, we aim to provide tools to better understand compound interactions and transport during pregnancy.
Skills to gain:	The undergraduate student will gain scientific and professional development skills on this project. In the lab, the student will learn several techniques including liposome formation, characterization, and transport studies. The student will be trained on using a NanoAssemblr, which is used for proteoliposome development in the proposed project. This instrument using microfluidic mixing technology to produce liposomes and lipid nanoparticles is currently used in the pharmaceutical industry for developing lipid nanoparticles (e.g. nucleic acid containing lipid nanoparticles, drug delivery liposome vehicles, polymeric particles, etc.). Skills including reading and analyzing scientific literature, maintaining a proper lab notebook, designing and executing experimental plans, and disseminating their work through written and oral communication will be highlighted throughout the summer research.
Accepted majors:	ChE, BME, BBT
A project for:	Rising sophomore, or Rising junior, or A student with minimal/no research experience, or A student with some research experience
Prerequisites:	None
Mentoring plan for the undergraduate student:	The student will be mentored by myself and a graduate student in the lab. We will provide advice and support throughout the process, fostering the proper use of deductive reasoning and the scientific method. As the student becomes more comfortable with the project, they will gain more independence in the lab through planning and executing experiments, analyzing data, and presenting their findings at regular group meetings. We will meet to discuss updates on their results often, where they will benefit from timely feedback. We will also provide appropriate oral and written communication skills. The student will be integrated into our research group through their involvement in daily lab activities, group meetings, and fun events the lab will have throughout the summer. Our new and growing research group is a collaborative and welcoming environment where all students can develop their creative and critical thinking skills towards becoming future researchers.

Department:	**Chemical Engineering**
Project title:	**Pharmaceutical Manufacturing: Continuous Flow Chemistry**
Faculty name:	**Andrew Teixeira**
Short project description:	America is moving to domestic pharmaceutical manufacturing, but we're not doing it batch-wise like we did in the past; this research combines pumps, tubes, heaters, and computers to build continuous flow pharmaceutical reactors.
Full project description:	Traditional small molecule manufacturing (Aspirin, Motrin, lidocaine, etc.), is done in a large batch pot that is scaled up. It requires a tremendous amount of wasteful solvent, has relatively poor control and most importantly, is slow! The pharmaceutical world is undergoing a major shift to continuous flow synthesis. Instead of flasks, we now use tubes and pumps. This takes a synthesis from the timescale of days and in plants that are the size of building to minutes in plants the size of refrigerators! In this project, you will focus on one key step: the highly exothermic hydrogen peroxide oxidation reaction. You will construct a reactor (coil of plastic tubing), apply temperature control (ice bath), set the residence time (pump/flowrate), and record conversion (e.g. UV). This will be done at many conditions to describe the underlying principles (heat transfer, mass transfer, kinetics) that are needed to scale key processes. You will also participate in a large research group (10-15 people), attend (and give) weekly presentations, with people researching in other areas (renewable energy, clean water, materials science, etc.).
Skills to gain:	Lab skills: pumps, reactors, automation/controls, analytical (UV, FTIR). Theory: mixing, heat transfer, reaction kinetics. Other: safety, presentations, communication. Finally, we are a close-knit group. You will learn from people from every background about their experiences and pathways into research as you explore your own options.
Accepted majors:	ChE, CH, BB, BBT, CS, ME
A project for:	Rising sophomore, or Rising junior, or A student with minimal/no research experience, or A student with some research experience
Prerequisites:	General chemistry; Orgo is helpful but not required. Depending on your background, we will tune the project (e.g. more programing/automation for CS, more kinetics for CH, more reactor design for CHE).
Mentoring plan for the undergraduate student:	The student will be expected to participate in lab every day, first working alongside a PhD student then independently. They will meet regularly with that PhD student. They will give status updates with myself (Faculty) in weekly research subgroup meetings and at least one safety talk and one technical talk to the entire group during our weekly full group meeting (~10-15 researchers). It will be a very immersive experience, including PhD students, postdocs, research professors, REU students, etc., as has been done in the Teixeira group for several years.

Department:	**Chemical Engineering**
Project title:	**Integrating Augmented Reality and Chemical Engineering**
Faculty name:	**Andrew Teixeira**
Short project description:	This project will challenge students to rethink how we teach engineering; we will leverage user-friendly software to convert the 3-story CHE lab into an interactive, fun tour that teaches CHE along the way!
Full project description:	We currently use augmented reality (AR) in the Unit Operations Lab and with some workforce development. In this project, you will be given a set of Microsoft Hololens glases and asked to make a fun, interactive game that guides the user through the unit operations lab. For example, starting in the basement, you will have the user find the master steam valve, then the distillation column, then where in the column the ethanol comes out, and what valve they would turn to increase the purity. They can then move upstairs to figure out how to make biodiesel. The whole thing will be more than a tour---it will have 3D holograms superimposed, videos, animations, and physical buttons that need to be pushed. It will be fun! Absolutely no coding experience in Unity or Guides is required. You just have to be creative and find this to be a cool thing to do. The exact project will also be guided by your interest (e.g. more coding or more application-driven; more artistic or more scientific).
Skills to gain:	Lab skills: you will be exposed to a lot of equipment (pumps, reactors, separation units, gauges, valves, etc.). Software: it depends on your interest (Microsoft Guides, Unity, LabVIEW, etc.), but you will gain some exposure here. Other: presentation/communication will be big; you will participate in group and subgroup meetings and expected to meet and discuss deliverables.
Accepted majors:	IMGD, CS, EE, ChE, CH (maybe others)
A project for:	Rising sophomore, or Rising junior, or A student with minimal/no research experience, or A student with some research experience
Prerequisites:	None required. It would be great if you have some interest in general programing, but no languages specifically. If you do have game design experience, it would help but not expected at all.
Mentoring plan for the undergraduate student:	The student will be expected to work in lab daily along side a PhD student at first, then independently. They will participate in formal weekly group (faculty + 10-15 researchers) and subgroup (faculty + ~5 researchers) meetings where they will present their progress. They will also present to the full group twice (once on safety, once technical). There will be substantial engagement with faculty and researchers throughout the summer, including group outings, etc.

Department:	**Chemical Engineering**
Project title:	**Impact of antimicrobial component of human milk on Staphylococcus epidermidis biofilm infections**
Faculty name:	**Elizabeth Stewart**
Short project description:	The student working on this project will investigate the impact of lactoferrin (an antimicrobial component of human milk) on S. epidermidis biofilm growth (a bacterial species responsible for infections in preterm infants) through experimental work done in the Stewart lab.
Full project description:	Staphylococcus epidermidis is a bacterial species that is a prominent cause of sepsis (a bloodstream infection) in preterm infants. To cause infections, S. epidermidis must form bacterial biofilms, which are structured, multi-cellular communities of bacterial cells encapsulated in self-produced matrix materials. Bacterial biofilms are less susceptible to antibiotics than individual bacterial cells. Increased consumption of human milk is associated with lower rates of late-onset sepsis in preterm infants. Human milk contains antimicrobial components whose concentrations vary with time. This early research experience project focuses on determining how the concentration of lactoferrin, an antimicrobial component of human milk, influences the growth and structure of S. epidermidis biofilms. Biofilm growth will be characterized using quantitative confocal laser scanning microscopy. This work is important to advancing the understanding of how human milk influences biofilm infections in preterm infants.
Skills to gain:	The undergraduate student engaged in this research will gain skills in experimental design, bacterial cell culture, florescence microscopy, and image analysis.
Accepted majors:	ChE, BME
A project for:	Rising sophomore, or Rising junior, or A student with minimal/no research experience, or A student with some research experience
Prerequisites:	None
Mentoring plan for the undergraduate student:	The undergraduate student will participate in group meetings that include all members of the research group and have a 30-45 minute team meeting with myself and the graduate student mentor every other week over the course of the 10-week research experience. The graduate student mentor will help to support the laboratory training and day-to-day experimental work for the undergraduate student with the aim of the student becoming increasingly independent over the course of the project. If additional team meetings are needed, the undergraduate and graduate student will communicate with the faculty advisor and we will add in additional research meetings to support the progress of the work.

Department:	**Chemical Engineering & Humanities & Arts**
Project title:	**Designing Hands-on, Context-Rich STEM Activities for Classroom Learning about Threatened Communities and Climate Change Refugees in Latin America**
Faculty name:	**David DiBiasio & Kris Boudreau**
Short project description:	Students involved in this research will work with faculty and graduate mentors to design, test, and improve a bench-scale model to be used in classrooms to teach climate change in threatened indigenous communities within Latin America.
Full project description:	
Skills to gain:	Library/database research; application of research; basic fundamental research standards and methods; ethics and social impacts in research; techno-economic analysis; site visits: observation, listening, interviewing; use of analytical equipment, including some of the following: spectrophotometry, gas chromatography, GIS mapping, 3-D printing, videography; teamwork; technical communication with non-technical audiences; curriculum development and learning theory and applications; building models; prototyping, testing, refining; engineering design; opportunity to co-author and/or present research papers and posters.
Accepted majors:	All majors
A project for:	Rising sophomore, or Rising junior, or A student with minimal/no research experience, or A student with some research experience
Prerequisites:	None
Mentoring plan for the undergraduate student:	Under the mentorship of Professors Boudreau and DiBiasio, the summer research intern will help design, develop, and test a kit (module) and associated curricula for middle school and higher levels that demonstrate the effects of climate change on threatened communities in Latin America. Boudreau and DiBiasio will mentor the student in the science of climate change and the design of a bench-scale model to demonstrate its effects. Professors Boudreau and DiBiasio will mentor on prototyping, testing, and curriculum development, including the cultural context of the community and themes of social justice. The student will join a team of undergraduates currently working on other curriculum kit design and testing, and the different teams will have a weekly meeting with Boudreau and DiBiasio, who will also be available for daily consultations. Weekly team meetings will be used to guide the student in forming research questions, finding sources, understanding school learning standards, and designing, building, and testing a prototype. The student will also have access to a machinist and an electrical engineer in the Goddard Hall labs .

Department:	**Chemistry & Biochemistry**
Project title:	**Photocatalyzed C–H Functionalization of Leucine Amino Acid**
Faculty name:	**Patricia Musacchio**
Short project description:	Students working on this project will assist in the development of a new organic chemistry reaction in the area of photochemistry
Full project description:	A current high priority project in the Musacchio group is to optimize a C–H functionalization reaction recently discovered in the laboratory. The reaction is catalyzed by a small molecule that absorbs visible light to enable the direct modification of strong C–H bonds. Specifically, the platform targets the tertiary C–H bond in leucine amino acid. The success of this reaction may result in the use of the reaction in bioconjugation efforts. Specifically, work on this project will involve screening several reaction conditions per week on a small scale and analysis of the reaction via NMR and GCMS techniques. Students will learn relevant organic chemistry lab skills as well as fundamentals of catalysis, CH functionalization, photochemistry, and reaction optimization.
Skills to gain:	Skills learned include: 1H, 19F, 13C NMR analysis; GCMS analysis; small scale reaction set up; reaction set up, workup; flash chromatography on gram scale; photochemistry; cyclic voltammetry; catalysis
Accepted majors:	CH, BCh
A project for:	Rising junior, or A student with some research experience
Prerequisites:	Organic chemistry I, II and III, CH2310, CH2330, CH2320
Mentoring plan for the undergraduate student:	The student will be paired with a graduate student or postdoctoral researcher in my lab for initial training in the relevant wet laboratory skills. Two meetings a week with the PI (myself) to discuss progress and literature papers related to the research area will add additional valuable mentoring for a complete student experience. The student will be included in all group lunch activities and group outings. The student will be encouraged to present their finding every other week in our group meetings to gain verbal experience.

Department:	**Chemistry & Biochemistry**
Project title:	**Investigation of cell signaling with photocaged complexes**
Faculty name:	**Shawn Burdette**
Short project description:	Students working on this project will apply molecules synthesized in the Burdette lab to investigate zinc-dependent signaling in cells
Full project description:	Metal ions are essential to numerous processes that sustain life. Among these important roles, metal ions carry the signals that enable learning, memory, and movement. While the functions of loosely bound metal ions like sodium, potassium and calcium are well-established, the role of vesicular zinc, which was found in neurons decades ago, in signal transduction remain ambiguous. Despite the lack of definitive mechanisms, circumstantial evidence suggests zinc can modulate the activity of a variety of ion channels, and zinc interactions with cell surface receptors may lead to a variety of intracellular responses. Photocaged complexes are chemical tools that trap zinc until a light source releases the metal ion at the desired time and location. Taking advantage of a light-induced decarboxylation reaction, zinc can be released inside cells with an appropriate light source.
Skills to gain:	Cell growth and manipulation - students will work with living cells such as human fibroblasts. Photolysis methods - students will use LED and other light sources to release metal ions from cages. RT-PCR techniques - students will monitor gene expression that is effected by zinc. Confocal fluorescence microscopy - students will look at zinc signals by looking at changes in emission of fluorophores
Accepted majors:	CH, BCh, BBT
A project for:	Rising junior
Prerequisites:	None
Mentoring plan for the undergraduate student:	Students will work directly with a graduate student mentor to learn techniques with the goal of becoming semi-independent over the course of the summer. Students will also participate in weekly group meetings by presenting their findings as well as observing the presentations of other group members. In addition, the department of chemistry and biochemistry has an active REU program that includes weekly career development seminars. All summer students are encouraged to take advantage of these activities

Department:	**Chemistry & Biochemistry**
Project title:	**Surface science of Metal Oxide Frameworks**
Faculty name:	**Ron Grimm**
Short project description:	Students will identify surface states and reactivity of Metal Oxide Frameworks (MOFs) relevant to the capping and trapping of guest molecules such as therapeutic drugs for drug delivery.
Full project description:	Students will identify surface states and reactivity of Metal Oxide Frameworks (MOFs) relevant to the capping and trapping of guest molecules such as therapeutic drugs for drug delivery.
Skills to gain:	General research excellence.
Accepted majors:	CH
A project for:	Rising sophomore, or Rising junior, or A student with minimal/no research experience, or A student with some research experience
Prerequisites:	Ch1010 through Ch1040 required, second-year lab sequence Ch2640–Ch2670 recommended
Mentoring plan for the undergraduate student:	I will mentor the undergraduate researcher.

Department:	**Chemistry & Biochemistry**
Project title:	**Stabilization of unstable semiconductors for enhanced photovoltaics**
Faculty name:	**Ron Grimm**
Short project description:	Students will learn how to passivate and characterize surface chemical states of semiconductors.
Full project description:	Students will learn how to passivate and characterize surface chemical states of semiconductors.
Skills to gain:	General lab excellence.
Accepted majors:	CH
A project for:	Rising sophomore, or Rising junior, or A student with minimal/no research experience, or A student with some research experience
Prerequisites:	Ch1010 through Ch1040 required, second-year lab sequence Ch2640–Ch2670 recommended.
Mentoring plan for the undergraduate student:	I will mentor the undergraduate researcher.

Department:	**Civil, Environmental & Architectural Engineering**
Project title:	**Wachusett Dam Construction**
Faculty name:	**Paul A. Marrone**
Short project description:	Investigate historical records to forensically describe how a major construction management project was logistically planned and scheduled with method that is still taught today.
Full project description:	Even today projects of any size are confronted with supply chain, lead times, change orders, unforeseen problems, labor shortages and strikes etc. The student will gain knowledge of how to react to these issues using contemporary resources at their disposal. These issues happened in real time and had to be addressed. Exactly as happens today, only the tools have changed. It is a really good illustration of how disparate contractors have to cooperate to reach a common goal.
Skills to gain:	Students entering the labor market in construction of large projects learn how to manage the work of intertwining contracts Some training in contract laws and rules; resource management; trade coordination
Accepted majors:	CEAE
A project for:	Rising sophomore, or Rising junior, or A student with minimal/no research experience, or A student with some research experience
Prerequisites:	No
Mentoring plan for the undergraduate student:	Complete a running narrative, as much as time permits, of progress and planning starting with notice to proceed, preconstruction activities and problem resolution.

Department:	**Civil, Environmental & Architectural Engineering**
Project title:	**Self-Healing Concrete: Extremly Durable Concrete**
Faculty name:	**Nima Rahbar**
Short project description:	The goal of this project is to evaluate the creep and fatigue performance of our newly developed Enzymatic Self-Healing Concrete
Full project description:	We have recently introduced a new paradigm for the universal repair of concrete using naturally occurring, inexpensive, and readily available enzymes to create self-healing concrete. The proposed carbonic anhydrase (CA) enzyme catalyzes calcium carbonate crystal precipitation that repairs concrete to its original strength by plugging the flaws. Using this transformative idea, a small amount of enzyme rapidly and effectively drives the reaction and precipitates crystals in large volumes]. Unlike current methods using bacteria, this method is inexpensive. It also repairs cracks faster by four orders of magnitude making it scalable to industrial applications and causing no risk to human health as the enzyme is safe and biodegradable. Using Rapid Chloride Permeability Testing (RCPT), we have previously shown that the proposed method can significantly enhance the durability of the concrete, the other mechanical properties of the enzymatic concrete remain to be investigated. Hence, in this EERE plan, shrinkage, creep, and fatigue properties of the self-healing enzymatic concrete will be thoroughly studied. The undergraduate student will prepare samples and perform the experiments based on the corresponding standard ASTM codes.
Skills to gain:	Basic analytical skills and knowledge of physics and chemistry
Accepted majors:	CE, ME, AERO, ChE, MSE, MA, PH, CH
A project for:	Rising sophomore, or Rising junior, or A student with minimal/no research experience, or A student with some research experience
Prerequisites:	Mechanics of Materials (analytical mechanics) or similar
Mentoring plan for the undergraduate student:	I work very closely with my graduate students and meet with them almost on a daily basis to discuss science and help them progress. I believe this helps their personal growth in addition to their scientific growth. Mentoring for this project will be similar to previous years. The results of my mentoring can be evaluated based on the success of my graduate students and undergrads who have worked in my lab. Just like in previous years, I also plan to meet with the student quite regularly during summer. While I plan to meet with undergraduate students on a weekly basis to monitor their progress, undergraduate students will be mentored closely by graduate students in their respective fields. For this project, Mr. Shuai Wang will be the graduate student leading the efforts in this project. While, in his third year as a Ph.D. student, Shuai has published three first-author papers in highly competitive journals such as "Matter." My Ph.D. students have always mentored undergrads during summer and Shuai has done an excellent job during the past 3 summers. Feedback from previous years can be a testament to his mentoring abilities.

Department:	**Civil, Environmental & Architectural Engineering**
Project title:	**Indoor air quality during wildfires**
Faculty name:	**Shichao Liu**
Short project description:	Students working on this project will investigate how wildfire affects indoor air quality, human exposure, and health
Full project description:	People spend most of their time indoors during wildfire seasons. Our buildings can be reservoirs of pollutants (e.g., VOCs, soot, particles) generated from wildfires since that pollution can penetrate the buildings through leakages/cracks of the envelope. A poor building ventilation system, such as ineffective air filters, brings polluted air into indoor space. Pollutants from wildfires can deposit (adsorption) on indoor surfaces and emit (desorption) gradually afterward. As such, the pollutants will linger indoors for a while even after the wildfires. This project aims to understand the adsorption and desorption process of VOCs from indoor surfaces (e.g., carpet, sheets, walls) generated from wildfires. The exposure level and health implications will be estimated from a pollution-transport model based on the VOCs measurement.
Skills to gain:	Basic chemical experimental skills, Good understanding of chemical physics
Accepted majors:	CH, ChE, EVE, and other relevant
A project for:	Rising sophomore, or Rising junior, or A student with some research experience
Prerequisites:	Courses related to chemistry and chemical measurements.
Mentoring plan for the undergraduate student:	1. The student will primarily work with a graduate student who can provide hands-on guidance/mentorship on the research. 2. The student will have weekly meetings with the faculty member and graduate student. 3. The student will have an opportunity to present the work in a conference. 4. The student will have an opportunity to coauthor a paper.

Department:	**Civil, Environmental & Architectural Engineering**
Project title:	**Interactive effects of thermal and interior ambient light environment on comfort, emotion, and driving performance**
Faculty name:	**Shichao Liu**
Short project description:	The project will investigate the hue-heat hypothesis and the interactive influence of temperature and interior ambient lighting on drivers' environmental satisfaction, emotion, and driving performance.
Full project description:	Creating a comfortable environment in automobiles enhances the satisfaction, safety, and experience of drivers and passengers. The tinted or semi-transparent window glazing "dims' daylight and helps relieve the visual discomfort and therefore offering enhanced visual comfort and also making driving safer. Some manufacturers, BMW and Mercedes, have intelligent windows that can change their transparency through electric signals. These smart windows can be dimmed when the sun is low on the horizon. While visual comfort might be improved by using tinted or semi-transparent glazing, there is little knowledge of how these techniques affect thermal comfort and perception. Recent studies on buildings showed light also influences thermal responses and comfort, but there is very rare research on automobile environment that could be much more complex owning to various driving scenarios.
Skills to gain:	Good communication and proactive attitude in research
Accepted majors:	All majors.
A project for:	Rising sophomore, or Rising junior, or A student with minimal/no research experience, or A student with some research experience
Prerequisites:	None
Mentoring plan for the undergraduate student:	1. Hands-on experience in data collection from human subjects. 2. Weekly meeting with faculty and graduate students. 3. Mentorship on research dissemination.

Department:	**Civil, Environmental & Architectural Engineering**
Project title:	**Immersive Space (Closed-Loop Brain-Computer Interface) using Adaptive Kinetic Architectural Design to Regulate Human Emotional States**
Faculty name:	**Soroush Farzin**
Short project description:	The student working in this project will investigate the link between architectural design features, human behavior, and brain activity by conducting experiments, data collection, and analysis.
Full project description:	Emotion represents how we process information and how we interact with our surrounding environment. Emotion is linked to behavior and brain dynamics, and in our recent research shows how human emotional states can be characterized through neural activity and behavior. Recent studies suggest that the built environment can significantly impact human psychology and cognitive behavior. This study addresses how environmental elements can be reshaped or redesigned to improve individual mental health by altering architectural design elements. In this research, we aim to build a pilot study to examine the link between architectural design features, human behavior, and brain activity. We designed an experiment that lets us record human physiological responses as we change the architectural environment. To accommodate more flexible changes, we use VR to change elements of architecture and utilize new advances in physiological signal recording - like EEG, heart rate, eye tracking - along with virtual reality (VR). Using the data recorded from a cohort of users, we conduct proper data analysis to identify the impacts of architectural components like dimension, color, and light on the behavior and associated neural activity.
Skills to gain:	The student will be involved in different research activities, including learning about: How to find and review relevant Literature on VR and human emotional state; How to design a human subject experiment specifically on the effects of the built environment(e.g. ambient light) on human behavior/performance; Conduct experiments and collect data; Post processing data and data analysis; Get involved in writing a scientific report/ research paper.
Accepted majors:	CS, AREN, CE, IMGD
A project for:	Rising junior, or A student with minimal/no research experience, or A student with some research experience
Prerequisites:	CS 2119-DX04 - Application Building With Object-Oriented Concepts or equivalent. CS 2301-DL01 - Systems Programming For Non-Majors or equivalent.
Mentoring plan for the undergraduate student:	Our mentoring goal is to help the participant experience the full spectrum of research activities over the period of the program. Based on shared goals, we try to establish ground rules and expectations at the beginning of the program. We define an informal assessment approach depending on the overall goal. Although we will have a weekly group schedule to go over weekly goals and progress, because of the open door policy, we will have daily interaction with the participants and our graduate students. We make sure the participant benefits from peer support and learning by assigning one graduate student as a mentor. Our mentoring goal is to help the participant experience the full spectrum of research activities over the period of the program. Based on shared goals, we try to establish ground rules and expectations at the beginning of the program. We define an informal assessment approach depending on the overall goal. Although we will have a weekly group schedule to go over weekly goals and progress, because of the open door policy, we will have daily interaction with the participants and our graduate students. We make sure that the participant benefits from peer support and learning by assigning one graduate student as a mentor.

Department:	**Computer Science**
Project title:	**Brain Data Exploratory and Analytics Tools**
Faculty name:	**Rodica Neamtu**
Short project description:	This is an interdisciplinary project aiming to interleave computer science, data science and neuroscience to create and expand exploratory and discovery tools for brain data
Full project description:	We are looking for motivated students to work on expanding and extending an existing complex pipeline for analyzing and learning from brain data. This project would provide opportunities for students interested in developing and implementing tools for machine learning, data science, feature selection, signal processing, and information visualization. Our tools have been customized to work with brain data and help researchers get insights into big collections of fNIRs signals that otherwise would be missed.
Skills to gain:	Key learning objectives include gaining an understanding of interdisciplinary brain data research, experience developing robust software platforms, and exposure to machine learning and data analytics. The goals of our project are two-fold: (1) Depending on student background and interest, the project may involve investigating tools for fNIRS exploration using Python, Matlab, D3, Javascript, etc, to enhance our existing data discovery and visualization pipeline; (2) In order to understand the interdisciplinary context, the students will engage in literature review, backend and user interface design and extension to incorporate machine learning tools.
Accepted majors:	CS, DS
A project for:	Rising sophomore, or Rising junior, or A student with minimal/no research experience, or A student with some research experience
Prerequisites:	None
Mentoring plan for the undergraduate student:	I have been acting as a mentor and advisor for many students for many years. I always work hard to get to know them and understand their goals and passions. I encourage my students to talk to me about anything, including academic, research, career advice, and mentoring. I meet with my students weekly to discuss their research and address their questions and challenges. I also organize a weekly meeting where my students share their work and actively try to help each other with constructive feedback and ideas. By interleaving supervised research, independent work, weekly one-on-one meetings, and weekly extended team meetings, the students will become an integral part of my research group and will get a better understanding of research and their interest in pursuing it. Their experience will involve conductive background research, understanding existing tools and methods, developing new tools and communicating about their work both verbally and in writing. My research group currently has one PhD student, and several master's and undergraduate students. In addition, my interdisciplinary research interests bring up opportunities to meet other undergraduate and graduate students.

Department:	**Computer Science**
Project title:	**Data-Driven Materials Science Applications and Tools**
Faculty name:	**Rodica Neamtu**
Short project description:	This is an interdisciplinary project aiming to interleave computer science, data science and materials science to create and expand exploratory and discovery tools novel materials
Full project description:	We are looking for motivated students to work on expanding and extending an existing complex pipeline for analyzing and learning from data from scanning electron micrographs to various powder types at variate magnifications. This project would provide opportunities for students interested in developing and implementing tools for machine learning, data science, feature selection, signal processing, and information visualization. Our tools have been customized to work with materials science data and help researchers get insights into big collections of powders that otherwise would be missed.
Skills to gain:	Key learning objectives include gaining an understanding of interdisciplinary data-driven materials science research, experience developing robust software platforms, and exposure to machine learning and data analytics. The goals of our project are two-fold: (1) Depending on student background and interest, the project may involve investigating tools for cold spray and flowability exploration using Python, Matlab, D3, Javascript, etc, to enhance our existing data discovery and visualization pipeline; (2) In order to understand the interdisciplinary context, the students will engage in literature review, backend and user interface design and extension to incorporate machine learning tools.
Accepted majors:	CS, DS
A project for:	Rising sophomore, or Rising junior, or A student with minimal/no research experience, or A student with some research experience
Prerequisites:	None
Mentoring plan for the undergraduate student:	I have been acting as a mentor and advisor for many students for many years. I always work hard to get to know them and understand their goals and passions. I encourage my students to talk to me about anything, including academic, research, career advice, and mentoring. I meet with my students weekly to discuss their research and address their questions and challenges. I also organize a weekly meeting where my students share their work and actively try to help each other with constructive feedback and ideas. By interleaving supervised research, independent work, weekly one-on-one meetings, and weekly extended team meetings, the students will become an integral part of my research group and will get a better understanding of research and their interest in pursuing it. Their experience will involve conductive background research, understanding existing tools and methods, developing new tools and communicating about their work both verbally and in writing. My research group currently has one PhD student, and several master's and undergraduate students. In addition, my interdisciplinary research interests bring up opportunities to meet other undergraduate and graduate students in the Data Driven Materials Science Research Group.

Department:	**Computer Science**
Project title:	**Measuring and Mitigating the Effects of Network Latency on Games**
Faculty name:	**Mark Claypool**
Short project description:	Students working on this project will investigate how network latency affects computer games and how techniques to mitigate latency's effects might be implemented and applied.
Full project description:	Even modest amounts of latency can degrade play for network computer games, but how much and for which games is not fully-understood. While software techniques to mitigate latency have been devised, how effective they are and for which games is not well-known, leaving room for innovation and evaluation. Students in this research project will: 1) analyze user study data to assess the impact of latency on games, 2) design and implement appropriate approaches for latency compensation, and 3) writeup findings in the form of a research report and presentation, including methodology, results and analysis.
Skills to gain:	Students will gain skills in one or more of: Reading research papers; Scripting (writing code to help with analysis, evaluation); Data analysis (statistics, charts); Dissemination (writing reports, presentations)
Accepted majors:	CS, IMGD
A project for:	Rising junior, or A student with some research experience
Prerequisites:	Some background and interest on computer games is helpful. Data analysis and programming courses are also helpful. Examples of useful (but not necessarily required) courses include one or more: CS 1004 - Introduction to Programming for Non-majors; CS 2301 - Systems Programming for Non-majors; CS 2102 - Object Oriented Design Concepts; CS 2303 - System Programming Concepts; IMGD 2905 - Data Analysis for Game Development; DS 1010 - Intro to Data Science.
Mentoring plan for the undergraduate student:	The student will work closely with my Latency and Games Research Group, which (in the summer) is primarily my 2 Ph.D. students and myself. This involves bi-weekly meetings as a group, plus individual meetings with the faculty advisor (Mark Claypool). In addition, Shengmei Liu (a 5th year Ph.D. student) will be a direct mentor for the student, providing research guidance and school/career advice.

Department:	**Computer Science**
Project title:	**Using ASSISTments to Improve Learning for 500,000 U.S. Students**
Faculty name:	**Neil T. Heffernan**
Short project description:	I will support two types of student projects: In the first, students will gain software engineering experience by learning how to write code before it goes live in "production" (the industry name used for the actual version of the web site that users see), and in the second, students will do machine learning behind some of our AI systems.
Full project description:	Founded by Neil and Cristina Heffernan, ASSISTments is a free online math platform that makes it easy for math teachers to assign their curriculum online and assess student progress in the classroom or remotely. ASSISTments is now used by about 20,000 teachers and hundreds of thousands of students. If you are interested in gaining experience as a software engineer, the proposed projects will be constructed around building or improving upon existing ASSISTments features with the goal of enabling teachers to reach more students. If you prefer to do something related to AI, we also have machine-learning projects, related to work in Natural Language Processing in which we are working to better understand student speech and written responses.
Skills to gain:	First are the domain skills. For the software engineering projects, students will learn to use Vue (if their project is focused on Front End) or Tomcat in developing RESTful API's for RESTful (for Back End components). For the second type of project students will use ML tools (TensorFlow) to build models and write python code. To make models work, you have to develop web services. Second are the soft skills of working and communicating with others on a large team with the goal of creating something for real-world, practical use. Projects may also involve other Learning Science & Technology faculty like Stacy Shaw (psychology and human learning analysis) and Adam Sales (statistics). You will gain practical real-world experience working with a professional and academic research team. Also, you will have to present your work to others and act upon their critical input. At the end of a positive experience we hope to write you glowing letters of recommendation.
Accepted majors:	CS, DS, MA, PSY (related to Learning Sciences), BUS, NEU
A project for:	Rising junior
Prerequisites:	To do well in the software engineering projects, Heffernan strongly suggests that you get an A in the Software Engineering course with an impressive project (or you have already demonstrated strong interest and skill in writing a lot of code). To do well in the machine-learning projects Heffernan suggests you have taken the AI or Machine Learning courses (or you have downloaded Tensor flow and used it in a project).
Mentoring plan for the undergraduate student:	Students will work closely with Dr. Heffernan to scope out a doable project that meets the student's interest and goals. Dr. Heffernan will meet weekly with the student and a PhD student who is actively working in that area. Dr. Heffernan has 20 years of experience in running over 150 IQP and MQP projects that have provided interesting projects for students to work on, while also providing something useful to the ASSISTments platform. Students will also work with Cristina Heffernan, co-founder of ASSISTments platform and Executive Director of The ASSISTments Foundation, the non-profit sponsored by WPI. Cristina Heffernan and Neil Heffernan will work as equal partners in steering the Early Research Experience in E-Term (EREE).

Department:	**Computer Science**
Project title:	**Developing and Studying Novel Sign Language Technology**
Faculty name:	**Erin Solovey**
Short project description:	This project takes a human-centered computing approach to build a foundation that advances understanding of how deaf individuals could work and learn in environments that are designed with their needs and preferences at the forefront.
Full project description:	Members of the Deaf Community whose first or primary language is American Sign Language (ASL) currently engage with interactive computer tools presented exclusively in English, including those designed expressly for ASL content and educational materials. The lack of ASL-based navigation is in part due to the fact that the signed languages of the world have unique requirements that do not align with existing text-based user interface design practices. In this project, students will explore previously developed and novel approaches that will allow users to engage with technological tools through a signed language with no reliance on conventional written language. To that end, all aspects of a user interface, including menus, search tools, and navigation buttons, be presented visually. The research team will look at the feasibility of incorporating photos, videos, illustrations, and characters representing the linguistic features of ASL vocabulary, such as handshapes, movement patterns, and location (i.e., placement on the signer's body). This interdisciplinary project would provide opportunities for students interested in human-computer interaction, accessibility, Deaf education, and user interface design.
Skills to gain:	Key learning objectives include gaining an understanding of interdisciplinary human-computer interaction and accessibility research methods, experience developing user interfaces and robust software following current best practices in software engineering, and exposure to American Sign Language. It may also involve conducting literature reviews and coordinating studies and interviews with human subjects to advance the research.
Accepted majors:	CS, IMGD
A project for:	Rising sophomore, or Rising junior, or A student with minimal/no research experience, or A student with some research experience
Prerequisites:	None
Mentoring plan for the undergraduate student:	I encourage all of my students to come talk to me at any time for any reason, including work/research related reasons, career advice, mentoring, etc. Through the process of supervised research, independent work, regular one-on-one meetings, and weekly project and lab meetings, the students will become an integral part of the research group and will gain insight into the related research conducted at WPI. The process of designing and running experiments, working with collaborators, collecting and analyzing data, presenting the work at conferences and ultimately helping in writing a research publication will all serve as excellent experiences for the students. My research group currently is made up of four PhD students, and several undergraduate students. In addition, the research group shares the physical lab space with four other research groups, all of which conduct research in human-computer interaction. Therefore, there would be opportunities to meet other undergraduate and graduate students in the area of human-computer interaction. The students will be provided with a workspace in the lab.

Department:	**Computer Science**
Project title:	**Improving Human-Computer Interaction with Real-time Brain Signals**
Faculty name:	**Erin Solovey**
Short project description:	This project combines computer science and neuroscience tools to study whether a computer could detect a person's cognitive state while using an interactive computing system.
Full project description:	We are looking for motivated students to work with us on exciting research on brain sensing and brain-computer interfaces, and applying them to interactive educational systems, medicine, and user experience research. This interdisciplinary project would provide opportunities for students interested in human-computer interaction, brain-computer interfaces, emerging sensor platforms, psychology, cognitive science, machine learning, data science, machine learning, feature selection, signal processing, and information visualization.
Skills to gain:	Key learning objectives include gaining an understanding of interdisciplinary human-computer interaction research methods, experience developing robust software following current best practices in software engineering, exposure to machine learning methods and training in experimental design and analysis. Depending on student background and interests, the project may involve investigating the architecture for robust fNIRS analysis tools, following current best practices in software engineering (Java, Python, Matlab, D3, Javascript, HTML, CSS) to enhance our testbed and dashboard for data processing and visualization. It may also involve conducting literature reviews, user interface design, and coordinating experiments with human subjects to advance human-computer interaction research. In addition, the project may focus on exploring machine learning approaches to classify brain data in real time or statistical analysis (Matlab,SPSS, Excel) and other analytic work on offline data sets.
Accepted majors:	CS, DS
A project for:	Rising sophomore, or Rising junior, or A student with minimal/no research experience, or A student with some research experience
Prerequisites:	None
Mentoring plan for the undergraduate student:	The students will attend all-hands project meetings and gain experience in having research-related discussions and coordinating activity amongst a larger team. Through the process of supervised research, independent work, regular one-on-one meetings, and weekly lab meetings, the students will become an integral part of the research group and will gain insight into the related research conducted at WPI. The process of designing and running experiments, working with collaborators, collecting and analyzing data, presenting the work at conferences and ultimately helping in writing a research publication will all serve as excellent experiences for the students. My research group currently is made up of four PhD students, and several Masters and undergraduate students. In addition, the research group shares the physical lab space with four other research groups, all of which conduct research in human-computer interaction. Therefore, there would be opportunities to meet other undergraduate and graduate students in the area of human-computer interaction. The students will be provided with a workspace in the lab.

Department:	**Computer Science**
Project title:	**Compiler-Assisted Embedded Systems Security**
Faculty name:	**Robert Walls**
Short project description:	Students working on this project will create a compiler that protects embedded software from attacks.
Full project description:	This project tackles the problem of securing embedded software. Rather than place the security burden entirely on embedded developers, the student's work will shift the enforcement of fundamental security properties to the compiler, using a combination of compile-time static analysis, runtime instrumentation, and hardware support. Their work will build upon store hardening, a nascent intra-address space isolation mechanism, to provide control-flow protection and memory safety.
Skills to gain:	- Methodologies for evaluating systems security research. - Threat Modeling. - System Design. - Writing, both in terms of research notebooks and a final project report (that will eventually form the basis for a research publication).
Accepted majors:	CS, ECE
A project for:	Rising sophomore, or Rising junior, or A student with minimal/no research experience, or A student with some research experience
Prerequisites:	CS 2303 (or CS 2301); CS 2011 (or ECE equivalent)
Mentoring plan for the undergraduate student:	We will meet at least twice a week in 1-on-1 meetings. Prior to the meeting, the student will be required to submit edited research notes for review (and discussion during the meeting). I will also be available for smaller, informal, chats throughout the week. The student will also have weekly meetings with my third-year Ph.D. student. Her role will be to give advice and feedback on the student's research and research processes.

Department:	**Data Science**
Project title:	**VisNLP 2.0: A Visual-Based Educational Support Platform for Learning Neural Network-Based NLP Analytics**
Faculty name:	**Chun-Kit Ngan**
Short project description:	We develop and implement a Visual-Based Educational Support Platform that enables novice learners to study the core processing components of Neural Network-Based NLP Analytics in sequence.
Full project description:	On the Internet, a large amount of text information is available. To process it, NLP is the technology that can understand and analyze text without requiring a human's help. However, to master NLP to develop such applications is not a trivial task, as it requires novice learners to have a good understanding of linguistic and computation that NLP is based on. To address this, we have developed and implemented VisNLP 1.0 for learning Statistical-based (SL) NLP analytics. VisNLP 1.0 is a web-based visual learning platform that enables learners to study the processing components of SL-based approach in sequence. This work has been accepted by the IVAPP 2021 conference. However, one critical problem that we have not addressed on is how the neural network-based (NN) methods could be developed and implemented visually to deliver the knowledge to learners. To address this problem, we will develop and implement VisNLP 2.0 that is the advancement of VisNLP 1.0. Specifically, the team in this project will focus on the development and implementation of the NN-based approaches. Using the interactive visual diagrams and charts being developed, we will visualize this approach to help learners understand its concepts, workflows, and uniqueness.
Skills to gain:	(1) Learn how to develop a NLP pipeline for Text Pre-processing. (2) Learn how to visualize NN-based NLP Analytics, e.g., Word2Vec (CBOW and Skip-gram). (3) Learn how to implement various performance metrics on text examples to demonstrate the difference between neural network-based and statistical-based methods.
Accepted majors:	CE, DS
A project for:	Rising junior, or A student with some research experience
Prerequisites:	Any course work and project experience related to python, deep learning, NLP analytics pipeline, text mining, data visualization, D3.js JavaScript library, etc.
Mentoring plan for the undergraduate student:	(1) 1.5 Week: Assign the relevant papers and materials to students to read and ask them to present their readings and findings. (2) 7 Weeks: Discuss the development and implementation tasks with students and ask them to present their work progress. (3) 1.5 Week: Wrap up the project and ask students to prepare the final project deliverables and presentation.

Department:	**Humanities & Arts and Interactive Media & Game Development**
Project title:	**Future(s) of Work and Technology**
Faculty name:	**Yunus Dogan Telliel**
Short project description:	Students will build a digital tool to help researchers understand and analyze potential workforce implications of the technologies they are building (e.g., the impact of AI and other automated systems on unemployment, job creation, worker reskilling).
Full project description:	The project aims to build a scenario-based forecasting tool. This tool will help researchers generate forecasts based on plausible and possible scenarios related to the implementation of new technologies (robots, AI, etc.) in various industries. The goal of scenario planning is not to predict what will happen, but to prepare researchers for future challenges. It can help researchers explore alternative futures, become aware of uncertainties and limits, and align research design with an inclusive and equitable vision of workforce development. The public conversation on the future of work is often polarized between optimists and pessimists, and both of these camps tend to narrowly think about the number of jobs created or made obsolete. While this calculus is important, the relationship between technology and workforce development is more complex. The quality, security, and meaning of work in new technology environments is equally important. Scenario planning has the potential to consider multiple driving forces and uncertainties from a holistic perspective. Researchers fluent in scenario planning will thus have skills to navigate changing ecosystems of work and technology.
Skills to gain:	This is part of an ongoing research project at WPI's Applied Robot Ethics Lab and NSF NRT Research Traineeship Program on 'Robots in the Future of Work'. This research has three components: 1) interviews with researchers funded by NSF's 'Future of Work at the Human-Technology Frontier' program, 2) construction of sample scenario analyses based on these interviews, and 3) building a digital tool that provides scenario planning prompts and guidelines. EREE students can participate in any or all of these components. Research skills: 1) Developing an understanding of scenario planning and other forecasting tools; 2) Qualitative research design and data management; 3) Interviews (recorded and unrecorded; structured and unstructured); 4) Communication design (related to the digital tool).
Accepted majors:	IMGD, HuA, SSPS, BUS, Engineering majors
A project for:	Rising sophomore, or Rising junior, or A student with minimal/no research experience, or A student with some research experience
Prerequisites:	None
Mentoring plan for the undergraduate student:	Week 1-3: We'll read about and compare various scenario planning (and other forecasting) tools; The student will read my draft articles on the topic; We'll 'reverse engineer' some scenario planning analyses (e.g., how they reach these conclusions from an initial set of questions and assumptions); A librarian will train the student on various ways of using library resources; The student will prepare an annotated bibliography; I'll introduce the student to interviewing as a research method. Week 4-7: The student will join me in most interviews; I'll introduce the student to transcription software; We'll do transcriptions; We'll construct sample scenario analyses that focus on workforce development. Week 8-10: We'll work on a practical guide that shows how to incorporate insights from scenario planning into research design and NSF grant proposals.

Department:	**Integrative & Global Studies**
Project title:	**"To be truly regenerative, we must be reparative": a BIPOC agenda for regional sustainable systems**
Faculty name:	**Sarah Stanlick & Katherine Foo**
Short project description:	Students working on this project will gain knowledge about the processes, practices, and collective power building of BIPOC (Black, Indigenous, and People of Color) farmers and food system actors to form regional networks that bear holistic visions for urban and regional sustainability that are deeply embedded in their communities.
Full project description:	Many Black Indigenous and other People of Color (BIPOC) communities identify regenerative soil, water, and energy systems as the basis for intergenerational healing from slavery and colonization. In this lens, the exploitation of land is based on the exploitation of people, and the regeneration of land depends on the regeneration of people. However, BIPOC are severely underrepresented in the agricultural sector. The purpose of this project is to understand the processes, practices, and collective power building of BIPOC farmers and food system actors to form regional networks that bear holistic visions for urban and regional sustainability that are deeply embedded in their communities. This project takes special interest in the ways that BIPOC knowledge of ecological processes and sustainability policy networks have shaped regional movements and flows. Integrative research gaps that will be explored during the planning period of the proposed project include: How does BIPOC ecological knowledge foster sustainable regional systems?; How do BIPOC sustainability policy networks foster sustainable regional systems?; What are the key assets and gaps determining the collective impact of BIPOC networks?
Skills to gain:	This would be a project that would be well-served by students interested in racial justice, environmental studies, sustainability, and/or sociology. Students will gain a conceptual understanding of regenerative agriculture, reparations, collective impact, and historical barriers and variables to BIPOC land stewardship. They will also learn about community-engaged research methods and ethical social science research. This includes, but is not limited to, asset-based community engagement and a systems-level view of social problems and their root causes. The students will also develop team building, surveying, presentation, public speaking, and team management skills.
Accepted majors:	ENV, CEAE, BB, PSY, among others.
A project for:	Rising sophomore, or Rising junior, or A student with minimal/no research experience, or A student with some research experience
Prerequisites:	Open to all. ENV130x Sustainable Cities would be a benefit. We would also like to prioritize the recruitment of a BIPOC student, if possible.
Mentoring plan for the undergraduate student:	We will be creating a small start-up list of readings and resources to prepare the students for the experience and ground them in existing research and theory as it pertains to the topic. The team will be meeting frequently, and student(s) will also have a role in planning and facilitating research meetings. The students will have weekly skills development workshops that will address public speaking, team communication, science communication, ethics, community-engaged research, and social science methodology and will be expected to also participate in SPUDs to create community with the other EREE students. The goal will be working towards a paper, network map, or other deliverable that will add to the larger understanding of our research topic and help prepare us for the work ahead in our NSF SRS grant. The students will have a lot of developmental support both in the conduct of the work and to develop their identity as a scholar.

Department:	**Integrative & Global Studies and Biology & Biotechnology**
Project title:	**Bird conservation in managed landscapes**
Faculty name:	**Marja Bakermans**
Short project description:	This study will examine habitat use of eastern whip-poor-will in a site in western Massachusetts that is managed by prescribed fire and mechanical treatments.
Full project description:	We conduct research focused on habitat management and conservation of declining bird species. My current project includes using the latest radio technology to track, identify, and characterize habitat used by breeding Eastern Whip-poor-will (Antrostomus vociferus) populations to identify priority habitats and management prescriptions. My research program aims to maintain healthy forest ecosystems and wildlife populations, where findings are translated into management recommendations and applied by natural resource professionals. I have been involved in a number of large-scale, multi-partner habitat management and monitoring efforts that produce real, on-the-ground differences in conservation, and I am proud of reaching out to and integrating a wide variety of stakeholders. For example, each project outline above is coordinated and collaborative with biologists at the Massachusetts Division of Fisheries & Wildlife (MassWildlife) and my targets species in the State Wildlife Action Plan, ensuring relevant and meaningful contributions to the field of conservation.
Skills to gain:	This student will learn valuable skills in defining and researching a problem before even stepping out in the field to collect the data. Of course, experimental design and field skills may be brand new to this student. This student will receive training in standardized methods in identifying bird species by sight and sound, breeding bird surveys, operating mist-nets, nest searching, handling, aging, sexing and banding birds, and conducting vegetation surveys. In addition, there may be an opportunity to work through radio-collected data to examine bird movements across habitats. This student will come away with a better understanding of practices in field-based conservation research to determine if this is a career path for them.
Accepted majors:	BBT, ENV, and others like EVE, CS, etc. with special interest
A project for:	Rising sophomore, or Rising junior, or A student with minimal/no research experience, or A student with some research experience
Prerequisites:	Although there are no prerequisites, the following courses would be helpful: GPS Extinctions, BB1002, BB1045, BB2030, BB2040, and BB2050.
Mentoring plan for the undergraduate student:	This student will join a network of undergraduate students and professionals that are committed to successful research endeavors. First, I aim to provide a sustained mentored relationship by actively inviting students to participate in my scheduled spring courses (e.g., BB1045, BB2050) and unscheduled ISUs (independent study courses or projects), for example a course on restoration ecology. Next, I provide peer support from students that have more experience in research because field skills are not taught in our courses during the academic year. I advise students in MQP projects over the summer, and if that occurs this year, the EREE student will also be mentored by an MQP student. Furthermore, I provide students with networking opportunities with local conservation organizations, like MA Division of Fisheries and Wildlife and Mass Audubon. Conservation biology presents an excellent opportunity to demonstrate collaboration among partners while in the field. I hope that EREE students will continue in my research program, conduct their own independent research, present data at a regional conference, and serve as a mentor for others in the future.

Department:	**Interactive Media & Game Development**
Project title:	**Social Creativity Support Tools for STEM Education**
Faculty name:	**Gillian Smith**
Short project description:	Students working on this project will investigate how socially-enabled creativity support tools can foster informal learning in STEM fields such as computer science and math.
Full project description:	The Code Crafters project investigates the application of generative design to informal computer science learning. In a workshop setting and using collaborative software that generates quilt designs based on user-stated preferences, quilters who have no computing background at all learn about CS concepts such as algorithms and data representation. In this summer research project, undergraduate students will investigate how we can take the underlying theories of Code Crafters and apply them in new contexts. Depending upon the background and interests of the student, this project may involve prototyping similar software for a new domain, augmenting the existing software with new features to strengthen its applications to CS learning, or investigate the application of the existing software for different learning opportunities.
Skills to gain:	Iterative design and prototyping, paper prototyping, identifying and evaluating learning outcomes, human subjects research (e.g. focus groups, user studies, interviews), qualitative data analysis.
Accepted majors:	Any majors welcome, IMGD or CS preferred but not required
A project for:	Rising sophomore, or Rising junior, or A student with minimal/no research experience, or A student with some research experience
Prerequisites:	None
Mentoring plan for the undergraduate student:	The Code Crafters project comprises two faculty advisors (myself and Prof. Anne Sullivan at Georgia Tech) and a research team with three graduate students (WPI IMGD PhD, WPI CS PhD, GT Digital Media PhD) and several undergraduate students including prior EREE students. Though it is not clear at time of writing how much of the research team will be available in the summer, at least two faculty + one graduate student will be active on the project. The EREE student will attend regular, weekly project meetings with the research team (including faculty), as well as more frequent meetings with the students working most closely on the relevant portion of the project. The student will meet with us once before the summer to identify their goals and interests and scope their project appropriately. We are interested in working with the EREE student to generate new ideas + prototypes for applications of a mature research project to new domains that the student has experience or interest in.

Department:	**Interactive Media & Game Development**
Project title:	**Modeling Diversity**
Faculty name:	**Farley Chery**
Short project description:	Students will apply creative skills to generate characters of color, limb differentiated peoples and under represented body types for 3D production.
Full project description:	Whether it be specializing in next generation hair or developing new skills to work productively in a fast paced environment. This project seeks to diversify animated media and create training modules for others to quickly grasp methodologies to improve the quality of 3D productions. Students can posses skills in any of these areas, modeling, rigging, python scripting, pyqt, unreal engine, motion capture or character design.
Skills to gain:	The ability to work quickly and efficiently in a 3D production pipeline and how to apply socially competent design choices to depictions of various people while avoiding stereotypes. Students will gain proficiency with Autodesk Maya and Maxon Zbrush, using their advanced feature sets to retopologize models. A major focus of this year's project is getting accurate dermal and sub-dermal skin tones for real-time animation.
Accepted majors:	IMGD, CS
A project for:	Rising sophomore, or Rising junior, or A student with minimal/no research experience, or A student with some research experience
Prerequisites:	AR/IMGD 2101, 3D MODELING I
Mentoring plan for the undergraduate student:	They will conduct the primary research and be given critical feedback from more experienced artist. Students will create 4 characters from blockout forms. Instead of a straight forward process the students will be treated as primary artist with faculty serving as a client and a senior undergraduate or grad student as a mentor. The faculty member will also act as a mentor but primarily will be giving EREE students suggestions on how to improve their workflow and how to conduct artistic research and project planning. The projects have 5 check-in points towards completion. The base blockout phase. The clothing stage, the merging of the body, retopology and coloring.

Department:	**Mathematical Sciences**
Project title:	**Modeling the action of Topoisomerase on DNA**
Faculty name:	**Abby Pekoske Fulton**
Short project description:	Students working on this project will computationally investigate the forces required and time span of the action of Topoisomerase II on DNA.
Full project description:	During processes of cellular replication and DNA compaction, a single DNA strand becomes either knotted or linked with another strand of DNA. For a cell to divide, the topological structure of DNA has to be simplified. Several enzymes play a role in untangling DNA. Topoisomerase II (Topo II) is particularly crucial, as it passes both strands of DNA through another double helical segment of DNA. Thus, Topoisomerase II simplifies the structure of DNA in a relatively efficient way. Using existing computational methods, we wish to model the action of Topoisomerase II on a segment of DNA. Our goal is to identify configurations of DNA in which Topo. II can bind to DNA, to examine the forces required to complete this strand passage, and to find the total time of the simplification process. To address these questions, we think of a DNA as an elastic rod immersed in fluid. This will allow us to use well established numerical methods and a Matlab code base to simulate the process of Topo II simplification. Students can modify existing code to complete the Topo II modeling process. This project will introduce students to the mathematical modeling process, and may give insights into how Topo II works in the context of cellular replication.
Skills to gain:	Students involved in the research project will learn the entire mathematical modeling process, from formulating the problem, numerical implementation, running simulations, to model validation. Students must have programming experience. Some familiarity with Matlab is ideal, but not required. Students will learn ways to apply calculus and differential equations to frame a biological problem in a mathematical context. They will use force balance equations to model DNA as a rod, and to model the forces required in the action of Topo II. Biologically, students will learn about the structure of DNA, how enzymes interact with a DNA strand, and the processes of cellular replication, DNA transcription, replication and compaction. Numerically, students will learn to implement an elastic rod model in Matlab, and how to translate force balance equations into numerical code.
Accepted majors:	MA, CS, BB, PH, BCB, BME, Engineering
A project for:	Rising sophomore, or Rising junior, or A student with minimal/no research experience, or A student with some research experience
Prerequisites:	Required: Multivariate Calculus (MA 1024), Programming Knowledge (CS 1004 or CS 1101). Strong Encouraged: differential equations (MA 2051) or intro to physics (Ph 1110 or Ph 1111). Preferred: Intro Biology (BB 1001 or BB1003).
Mentoring plan for the undergraduate student:	The primary mentor will be myself (faculty). Students will primarily work with me throughout the background, set-up and implementation steps of the project. They will also spend time working with Dr. Sarah Olson's research group, and other undergraduate and graduate mathematics students. Students will sit in on and present in Dr. Olson's research group seminar. Here they will have the opportunity to collaborate with undergraduate and graduate students working on similar research projects throughout the summer. They will also be given generic advice on succeeding in their major, career advice, potential career paths, internships and other summer research opportunities, and steps needed to apply to graduate school.

Department:	**Mathematical Sciences**
Project title:	**Mixing by Microswimmers at Fluid Interfaces**
Faculty name:	**Nicholas Chisholm & Sarah Olson**
Short project description:	The student will develop a model to predict mixing generated by a collection of microswimmers, e.g., a colony of motile bacteria, at air- or oil-water interfaces.
Full project description:	When collections of microorganisms swim, they also generate fluid motion in their environment which transports nutrients, signaling molecules, or other substances. While past work has quantified mass transport due to such "microswimmers" in near rigid surfaces, mobile surfaces such as fluid interfaces, remain much less well characterized, and there are no theoretical estimates of the mass transport rates in these environments. Towards filling this gap in knowledge, the goal of the project is to quantify mass transport at air/oil-water interfaces by computing the effective diffusion coefficient induced by a "bath" of active swimmers with random trajectories. The diffusion coefficient measures the rate of spreading of a substance through space. The student will, with the guidance of their mentor, develop understanding of the fluid mechanics principles important to swimmer locomotion and of the advection-diffusion equation governing mass transport. The student will then employ an appropriate ensemble averaging method to these equations to extract the desired diffusion coefficient. The work of the student will have impact in the fields of fluid mechanics and mathematical biology.
Skills to gain:	Major skills the student is expected to gain are as follows: 1. Mathematical modeling of an open-ended research problem; 2. Assessment of model by comparison to experimental results; 3. Reading and understanding technical academic literature; 4. Understanding of mathematical concepts that relate specifically to their project including partial differential equations, laplace transforms and their application to ordinary differential equations, continuous random variables and probability distributions; 5. Oral communication skills through presentations at group meetings; 6. Written communication skills through preparation of reports and/or parts of an academic research article.
Accepted majors:	MA, ChE, ME, PH
A project for:	Rising junior, or A student with minimal/no research experience, or A student with some research experience
Prerequisites:	Multivariable calculus (MA 1024), Ordinary differential equations (MA 2051)
Mentoring plan for the undergraduate student:	The EERE program will start with a series of introductory tutorials, presented by myself or other group members, designed to help transition program participants into their research projects. Tutorials will review and/or introduce critical topics: fundamentals of vector algebra/calculus, fluid mechanics, mass transport, mathematical biology, and numerical modeling. The student will meet individually once or twice weekly with their faculty and graduate student mentors. Initially, the goal of the meetings will be to guide the student through a focused literature review. The mentor will guide the student towards adapting methods in published literature to their particular problem. Later meetings will focus on guiding the student coaching the student through technical challenges of their research project and challenging the student to determine next steps. The student will be integrated into the research group by giving short, informal presentations of their progress each week to practice of oral communication skills and garner feedback on their work. The student will attend research presentations of other EREE students and members of the Olson group, allowing them to participate in the broader research focuses of the group.

Department:	**Mechanical & Materials Engineering**
Project title:	**An Exoskeleton-Based Motion Capture System**
Faculty name:	**Yihao Zheng**
Short project description:	Students working on this project will design, fabricate, and test an exoskeleton with sensors integrated for human motion tracking.
Full project description:	This project is to design, fabricate, and validate a lightweight, low-cost, exoskeleton system for high-resolution human motion tracking. The main design objective is to minimize the interference from the exoskeleton to human normal activities. Inertial measurement units and multi-body dynamics will be used. Additive manufacturing and machining might be involved. This is a hands-on project integrating mechanical, biomedical, robotics, and electrical engineering.
Skills to gain:	Design, hands-on prototyping, 3D printing, Machining, Inertial measurement unit, Multi-body dynamics, Data collection and processing, Experiment design
Accepted majors:	ME, RBE, BME
A project for:	Rising sophomore, or Rising junior, or A student with minimal/no research experience, or A student with some research experience
Prerequisites:	None
Mentoring plan for the undergraduate student:	Students will be guided by me. Weekly meetings will be scheduled. Students will have the opportunity to work with other researchers in my lab as well.

Department:	**Mechanical & Materials Engineering**
Project title:	**Experimental Investigation of Mechanical Thrombectomy for Stroke Treatment**
Faculty name:	**Yihao Zheng**
Short project description:	Students working on this project will develop a setup and perform experiments to investigate a medical device used to remove blood clots from the cerebral artery inside the brain for stroke treatment.
Full project description:	Stroke is the number one cause of long-term disability in the US. Stroke can be caused by an artery inside the brain blocked by a blood clot. To treat stroke, a long flexible tube, also known as a catheter, will be passed from an incision on the thigh through the arteries all the way into the brain and suck the clot out using a vacuum. During this procedure called mechanical thrombectomy, many things could go wrong. In this project, students will build an experimental setup simulating the blocked artery inside the brain and perform the mechanical thrombectomy procedure to understand potential failure mechanisms.
Skills to gain:	Medical device testing, Medical simulation, Prototyping, Experiment design, Data collection
Accepted majors:	ME, RBE, BME
A project for:	Rising sophomore, or Rising junior, or A student with minimal/no research experience, or A student with some research experience
Prerequisites:	None
Mentoring plan for the undergraduate student:	I will directly work with the students. Weekly meetings will be scheduled for project updates and discussion. Students also have opportunities to work with other researchers in my lab on this project.

Department:	**Mechanical & Materials Engineering**
Project title:	**Low-Cost Efficient Magnesium Metal Production for Light Vehicles and Energy Storage**
Faculty name:	**Adam Powell**
Short project description:	Students will work with a PhD student on high-temperature (500-1000°C) electrochemistry experiments and models to demonstrate and start to scale up a new class of magnesium metal production technology.
Full project description:	Magnesium (Mg) metal is an outstanding light-weight material for motor vehicles. Aluminum can reduce the weight of vehicle body parts by 30-40% vs. steel, Mg by 60-70% vs. steel. This leads to longer electric vehicle range, better performance, and reduced tire/suspension demands. But Mg is more expensive ($3-4/kg vs. aluminum $2/kg, steel 50¢/kg) mostly due to the complex processes required to produce it. Mg is also an energy carrier for potential use in negative-emissions aircraft fuel, or Mg-air batteries for powering ships with 20-30 times the energy of a lithium battery. The Energy Metals Research Group (EMRG) is developing a new process which can make Mg for less than the cost of aluminum. It uses cheap MgO in a molten salt electrolysis process to make Mg metal. The process runs at 500-1000°C, which enables 1000-10,000 A/m² current density – 3-30 times higher than aqueous copper electroplating. Students will run experiments in the EMRG high-temperature electrolysis apparatus in the Washburn foundry. They will participate in modeling using thermodynamics, multiphase fluids + heat and mass transfer, and structural analysis. Models will help us to lab experiments and full-scale industrial electrolysis cells.
Skills to gain:	Skills gained in this project include: Extensive lab safety training, as it involves chemical, heat, and electrical hazards; High-temperature electrochemistry and related modeling skills; Modeling with fluds ad heat and mass transfer, possibly including finite element analysis; Techno-economic cost, energy, and emissions modeling of the process; Possible opportunity to work with a company to scale up the process; Possible work on customer discovery for commercialization via the National Science Foundation i-Corps program. The goal is to work through the process from initial concepts to launching scale-up and commercialization, whether that commercialization happens at a startup or large company.
Accepted majors:	ME, ChE
A project for:	Rising sophomore, or Rising junior, or A student with minimal/no research experience, or A student with some research experience
Prerequisites:	ES 2001 Introduction to Materials Science and ES 3001 Thermodynamics are very helpful but not necessary.
Mentoring plan for the undergraduate student:	The research mentoring plan is based on gold standard project based learning: It will develop key knowledge about the subject matter in the problem subject area; This is a very challenging open-ended problem; Students will develop their own solutions and share in the invention process; It is a real-world problem; Students will scope and plan out the project and follow that plan, guided by the mentors; There will be opportunities throughout the summer for reflection and updates to the plan and research practice; Students will participate in giving and receiving 360° feedback throughout the group; There will be public products of the project results, including a final presentation, and participation in one or more publications. The graduate student will work most closely with the participants every day. The faculty member will have an initial meeting focused on the undergraduate students, at least one formal meeting per week with the team, multiple informal check-ins each week (particularly in lab), and a final meeting and presentation of results.

Department:	**Mechanical & Materials Engineering**
Project title:	**Environmental friendly recovery of valuable materials from e-wastes**
Faculty name:	**Jianyu Liang**
Short project description:	Students working on this project will be challenged to develop advanced technologies to address current barriers in recycling of e-wastes.
Full project description:	E-waste is the most rapidly growing waste stream at a rate of 3-4% per year globally. UN led study in 2020 show that only 17.4% of e-waste has been formally recycled. According to Alianza Recycling: "Fewer than 20% of cell phones are recycled each year, but if we recycled just a million cell phones, it would reduce greenhouse gas emissions equal to taking 1,368 cars off the road for a year." In this project, students will be challenged to identify the main barriers to the efficient recycling of e-wastes and develop technologies enabled by artificial intelligence and robotics to address these barriers. Students will work in team with post doctoral researchers and graduate students and learn about literature research, materials characterization, and/or machine learning methods.
Skills to gain:	Students will learn to conduct literature research, critical thinking, information and data synthesis, experiment design, materials characterization, data analysis, and scientific presentation in oral or written forms.
Accepted majors:	ME, ChE, CEAE, ECE, CH, PH, RBE
A project for:	Rising sophomore, or Rising junior, or A student with minimal/no research experience, or A student with some research experience
Prerequisites:	Chemistry and physics classes in freshmen or sophomore year are desirable.
Mentoring plan for the undergraduate student:	The student will work closely with a team of a post doctoral fellow and two graduate students. The undergraduate trainee will be expected to participate and contribute to the weekly research group meeting with the faculty advisor and the rest of the research team. The student is also expected to have weekly discussion with the faculty advisor. Necessary laboratory training will be provided by lab managers and senior PhD students. Lab work will be supervised by post doctorial fellow and graduate students. This topic is a part of a larger resource recycling research effort with a research symposium planned in the summer. The undergraduate trainee will be prepared to participate in this event and network with the research community.

Department:	**Mechanical & Materials Engineering**
Project title:	**3D Printing Smart Materials for NASA Moon and Mars Applications**
Faculty name:	**Danielle Cote**
Short project description:	This project will give students first-hand experience and exposure using materials science and engineering techniques to produce additively manufactured (3D printed) smart materials as part of an exciting research project with NASA.
Full project description:	NASA uses shape memory alloys for a variety of applications for both moon and Mars missions, as shape memory alloys are considered "smart materials" and have very unique properties. The research highlighted in this project uses an additive manufacturing (3D printing) technology to form shape memory alloys for various NASA applications. The project will considering the materials science and characterization of all aspects of the process, from metal powder to consolidated properties. Micromechanical analysis, microscopy, chemical analysis, crystal structure analysis, and more will be considered.
Skills to gain:	The student will gain first-hand experience in a state of the art materials science and manufacturing research lab. Specifically, the research area highlights metal alloys for additive manufacturing (3D printing) applications. Additionally, they'll interface with NASA scientists on a real-world research program to help develop materials for NASA space missions. Finally, they'll participate in research meetings with graduate students, postdocs, faculty, and research engineering professionals, providing an engaging experience.
Accepted majors:	ME, MSE, ChE, PH, CH, any others interested in materials!
A project for:	Rising sophomore, or Rising junior, or A student with minimal/no research experience, or A student with some research experience
Prerequisites:	ES 2001 - Introduction to Materials Science
Mentoring plan for the undergraduate student:	Ph.D. student, Eva Piazza, is the lead Ph.D. student in my research group on this project. Eva was a residential advisor as an undergraduate at WPI and is already an exceptional leader and mentor. Eva will be the first point of contact for the student, and will manage their day-to-day interactions. At a larger scale, the student will join my Cote Research Lab research group weekly meetings and will be invited to share their progress on the project. They'll also be invited to shadow other lab members in their various experiments and analysis to get additional first-hand exposure to more state-of-the-art instrumentation and techniques.

Department:	**Physics**
Project title:	**Controlling the activity of the active fluid with light using light-sensitive DNA hybridization**
Faculty name:	**Kun-Ta Wu**
Short project description:	Utilize DNA to engineer nanoscale molecular motor proteins so as to control the macroscopic millimeter-scale turbulence-like mixing flow of microtubule-based active fluid.
Full project description:	Active fluid liberated from equilibrium constrain can perform the task beyond the limit of conventional passive fluid such as pumping fluids without pumps. This capability has been used in numerous applications such as molecular shuttles and optical devices. However, bringing the application to the next level requires the ability to control the active fluid activity in situ. To achieve such controllability, we will redesign the power source of the active fluid: molecular motor proteins. In the active fluid system, the motors were dimerized to drive pairs of microtubules whose motion stirred the surrounding liquid to cause fluid flows. The flow could be ceased manually if the motor dimers could be disintegrated into monomers in situ. To reach this goal, we aim to conjugate the motor proteins with azobenzene-tethered DNA, allowing for dimerizing the motors using DNA hybridization. Since hybridization of the azobenzene–DNA depends on exposure to specific wavelengths of light, the motor dimerization is expected to be controlled with light. We expect that this work will enable us to accelerate and decelerate the flows of active fluid manually like a gas pedal of a car.
Skills to gain:	1. Gain basic wet lab skills such as pipetting and titration. 2. Coat the glass surface with polymers. 3. Express proteins in bacteria. 4. Purify proteins using chromatography. 5. Examine purity of protein and DNA samples using electrophoresis gels. 6. Polymerize microtubules. 7. Conjugate snap tagged proteins with benzylguanine groups. 8. Design DNA sequences. 9. Synthesize kinesin-driven, microtubule-based active fluids. 10. Image fluorescently labeled samples with epifluorescence microscopy. 11. Analyze data with MATLAB, including using the algorithms of particle tracking and particle image velocimetry. 12. Perform parallel computation on Turing clusters. 13. Keep a lab notebook. 14. Give oral presentations. 15. Compose posters with Adobe Illustrator.
Accepted majors:	PH, ChE, BME, BBT, CBC
A project for:	Rising sophomore, or Rising junior, or A student with minimal/no research experience, or A student with some research experience
Prerequisites:	None, but a passion toward the fundamental science is prerequisite.
Mentoring plan for the undergraduate student:	The student will be paired with one of my graduate students, Teagan Bate to learn basic research skills such as pipetting and data analysis. The student will also join our weekly group meeting to learn how the scientific research is discussed and progressed. To enhance the student's awareness of the research outside WPI, the student will be encouraged to join New England Complex Fluid Workshop in UMass Boston in June, which will also broaden the student's connection to nearby scientists in the similar field. Additionally, my lab is closely connected with NSF MRSEC at Brandeis University in Waltham. I will arrange the student to participate in the meeting of Interdisciplinary Research Group (IRG). I envision such an activity will provide the student a unique opportunity to engage with the MRSEC director, as well as pave the path to student's career development.

Department:	**Physics**
Project title:	**Sensor development for physiological monitoring**
Faculty name:	**Doug Petkie**
Short project description:	Students will work in the lab on the experimental development of a radar-like sensor system to monitor vital signs or for chemical breath analysis.
Full project description:	We use extremely high frequency radio waves for R&D projects where the fundamental physics is favorable for the development of sensor systems. We have been developing sensors for physiological monitoring, such as remotely measuring vital signs (Star Trek Tricorder) or for breath analysis. For vital signs, a radar system will be developed to measure micro-Doppler signatures of human gait and vital signs for remote identification of activities or triage applications. The radar system acts to monitor the motions of the body, including the mechanical shuttering of the body in response to the heart beating, blood flowing, and lungs expanding that can measure the heartbeat and breathing rates. The challenges are to test the limits of the system in different circumstances. For instance, can we measure the heartbeat rate of a person at 100 meters among a crowd? The same technology can be leverage quantum physics and identify some of the over 1,000 molecular compounds exhaled in human breath. In this case, the technology is turned into a molecular spectrometer to identify gas phase molecules, much like is done to identify molecules in interstellar clouds. Can this technology lead to the identification of respiratory diseases?
Skills to gain:	Projects are experimental and hands-on in nature. Students will learning the basic physics of the sensors along with the fundamental design and building of experiments, data analysis, and modeling of physical phenomena. With any project, literature searches and reviews are essential to understand the how the project fits into the context of past and present research and identify the value it contributes toward new scientific knowledge and how new technologies can benefit society. In the lab, we utilize data acquisition systems, instrument control, high frequency (millimeter-wave/THz) instrumentation, and optical and photonic technologies (sources and detectors). Teamwork and collaboration are essential with each project. Communications and presentation skills will be developed in group meetings, writing reports, presenting posters, giving informal and professional talks and well as drafting manuscripts. There are no prerequisite courses required past the first year of courses.
Accepted majors:	PH, PHA, ECE, BME, CBC, ME
A project for:	Rising sophomore, or Rising junior, or A student with minimal/no research experience, or A student with some research experience
Prerequisites:	None.
Mentoring plan for the undergraduate student:	The mentoring plan has multiples levels. I meet with students frequently (at least 2-3 times weekly) and I am typically in my office and/or lab every day and available. We have weekly group meetings to review progress and discuss the next steps and celebrate any successes. I have three PhD students (one is remote) and usually 3-4 undergraduate students in the lab each summer from a combination REU students, MQP students, or interns associated with externally funded projects. We may also host an RET undergraduate and high school teacher in the lab this summer. I have several discussions with new students the first 1-2 weeks to determine skills and interests to adapt the project that best matches their goals. I observe the group dynamics and personnel interactions to promote a healthy and beneficial lab environment for everyone. We leverage EREE and REU summer training and programming to complement and reenforce mentoring done in the lab. Our laboratory is in the Lab for Education and Application Prototypes and has several common areas where undergraduate and graduate students get together from five other interdisciplinary research groups (Physics, ME, Materials, and Mathematics) get to collaborate and socialize.

Department:	**Systems Engineering**
Project title:	**Systems Modeling Language Application and Research**
Faculty name:	**Shamsnaz Bhada**
Short project description:	The students working on this project will learn Systems Modeling Language and apply it to a research project
Full project description:	This project digitizes natural language of policy and analyze gaps along using SysML modeling for policy.
Skills to gain:	Some computer programing experience will be great
Accepted majors:	CS, ECE, IMGD, SSPS
A project for:	Rising junior, or A student with some research experience
Prerequisites:	None
Mentoring plan for the undergraduate student:	I usually meet with students twice a week and help them learn SysML. I also include them in my research meeting and help them develop the poster at the end of summer

Department:	**Civil, Environmental & Architectural Engineering**
Project title:	**Integrating plastic waste in microflush toilets**
Faculty name:	**Aaron Sakulich**
Short project description:	Microflush Toilets are an off-grid, low-cost, sustainable technology that is being deployed in many remote and impoverished regions. The toilets are designed to require a minimum of materials to build while encouraging improvements in hygiene and reducing disease. They also use vermiculture techniques to transform waste products into fertilizers, producing a valuable material and a potential income stream in poor agricultural areas. Most toilets have a similar design: a small building sitting over a pit into which waste is dropped. Inside the pit, there is a mesh at the bottom that allows liquid materials to drain away into the subsoil. Should the liquids build up in the pit, it would not only create unpleasant odors, but kill the worms necessary for vermiculture operations.
Full project description:	Although these toilets have been deployed successfully in a number of countries, including Ghana and Haiti, their implementation in Ethiopia is proving challenging due to a lack of raw materials. Wire screens, used elsewhere as meshes at the bottom of the waste pit, are simply unavailable in Ethiopia. There is, however, on material that is available in abundance: Plastic waste. Some plastic waste is in the form of flimsy, thermoplastic materials from shopping bags and plastic sheets, and some comes in the form of harder, more durable thermoset materials from different containers or commercial packaging. The goal of this project is to improve the adoption of microflush toilets and reduce a common waste source by investigating woven plastic wastes as a replacement for the metal grids that are used elsewhere. Plastic appears in abundance, and can be easily manipulated by local artisans with relatively little need for capital equipment; it may be possible to use plastic to replace the meshes at the bottom of the waste pit - meshes that are critical to the correct operation of the toilets, but unavailable in Ethiopia; and doing so would both consume a significant quantity of waste and provide local economic opportunities.
Skills to gain:	Students working on this project will combine literature reviews and laboratory studies to investigate: a) how waste plastics can be woven to increase strength and durability; b) whether such woven plastics have sufficient mechanical properties to be used to replace the metal meshes used in Microflush toilets elsewhere; c) and whether such woven plastics have sufficient chemical properties (that is to say, if such woven plastics would be susceptible to corrosion or chemical alteration in the identified service conditions.
Accepted majors:	All majors.
A project for:	Rising Sophomore, or a Rising junior, or A student with minimal/no research experience, or A student with some research experience
Prerequisites:	None
Mentoring plan for the undergraduate student:	The mentoring plan will be based on my experience as a mentor in over two REU sites. I will be collaborating as advisor with Rob Kruger; he will provide information and guidance regarding the context of the project in Ethiopia, whereas I will oversee the actual technical research and laboratory activities. This will entail the "big picture" guidance and will encompass both literature review and laboratory work. For day-to-day activities the EREE participant will work under the supervision of the CEAE lab supervisor, Russ Lang, and potentially a graduate student that can help with running instrumentation. The EREE participant will of course be involved in all EREE activities to foster a sense of community, and will also receive training (ethics, literature review, technical writing, etc.) as needed based on materials developed for my former REU sites and/or courses at WPI.