Undergraduate Research Experience 2018

Faculty & Research Projects

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COLLEGE OF ENGINEERING AND COMPUTER SCIENCE

CIVIL AND ENVIRONMENTAL ENGINEERING

1. Dr. Beena Ajmera

Projects Available for URE18:

1. GIS-Based Landslide Hazard Mapping for Pre- and Post-Earthquake Rainfall in Nepal
   - Billions of dollars are lost throughout the word due to landslides alone. Rainfall and earthquakes are two among the major triggering factors of landslides. If these two triggering factors affect the slopes together, the number of landslides that can occur significantly amplifies.
   - Two among the recent major earthquakes, 2011 Japan Earthquake and the 2015 Nepal Earthquake, occurred in dry seasons. The entire world was worried about potential large-scale landslides during post-earthquake rainfall.
   - In this project, students will prepare database of landslides before the earthquake event, right after the earthquake, and right after the post-earthquake rainy season to evaluate if the post-earthquake rainfall triggered any landslides.

2. Use of Recycled Materials in Civil Engineering Infrastructures
   - Recycling of waste materials in construction applications is currently gaining lots of attention due to an increase in the amount of industrial waste causing a heavy disposal cost and the resulting negative effects on the environment.
   - One source of waste materials is scrap tires. It is estimated that, in the United States, a person scraps 1.1 tires a year, leading to an average of over 300 million scrap tires a year. These scrap tires occupy landfill space as they are non-biodegradable, contaminating the environment as they are considered as toxic waste, and pose a significant hazard.
   - In this project, students will examine how the soil type as well as the quantity and size of shredded rubber tires influences the properties of soil-rubber tire mixtures. The research will focus on evaluating the possibility of using scrap tires into civil engineering applications including backfill of retaining walls, pavement for sidewalks and walkways, and embankment as well as ground improvement to increase the load bearing capacity of weak foundation soils.

Desired preparation for this lab: No additional preparation is required. I will take the responsibility to ensure that the students have sufficient background during the summer research activities to fully benefit from their participation in the projects.

2. Dr. Pratanu Ghosh

Research Interests: My research interests focus on durability and sustainability of various concrete materials which can be applied to our nation's infrastructure especially in concrete bridges, pavements and dams. I use advanced experimental technologies using cutting edge non-destructive equipment and numerical methodologies using service life modeling software. As nation's most concrete bridges are in dire need for rehabilitation and retrofit, it is necessary to use high performance sustainable durable concrete and investigate their performance by computing their intended service life.

Projects Available for URE18:
1. Investigate service life modeling of bridge slabs and pavements using life 365 software. Corrosion is one of major problems that deteriorate reinforced concrete over time. Students can compute corrosion initiation time and corrosion propagation time using diffusion coefficients of various sustainable cementitious materials and finally compute service life of bridges and pavements.

2. Investigate Surface Electrical Resistivity and Shrinkage of concrete samples using non-destructive testing techniques. More testing is needed for different high performance concrete mixtures for future implementation in reinforced concrete bridges and pavements.

Desired preparation for this lab: Students need to know basic statistical analysis and Excel and some basic lab training to conduct experiments. Our lab technician can help to provide adequate training to use the equipment.

3. Dr. Sudarshan Kurwadkar

Research Interests: My research interests are in the broadly defined areas of physical and chemical processes in environmental engineering. Specific examples are fate and transport of emerging contaminants such as pharmaceuticals compounds and insecticides in the environment; sorption and degradation kinetics of organic contaminants, and water quality investigations particularly water quality impact due to intensive animal agriculture operations. Currently, I am working on developing a bench scale module for removal of carbamazepine drugs from wastewater using UV-LED radiation source.

Projects Available for URE18:
1. Removal of pharmaceuticals using UV-LED radiation source from water and wastewater

2. Speciation dependent degradation of selected organic compounds

3. Photocatalytic removal of various organic compound

4. Water quality measurements for evaluation of health of water bodies

5. Modes of pesticide application and their fate and transport in the environment

6. Field-scale monitoring of pesticides using Enzyme-Linked Immunosorbent Assay

Desired preparation for this lab: Students should have knowledge of chemistry and have prior laboratory experience. Willingness to conduct laboratory experiments, tabulate data, and synthesize. Students should be willing to learn new analytical equipment such as Microtiter plate reader, High-performance liquid chromatography, and UV spectrophotometer.

4. Dr. Garrett Struckhoff

Research Interests: My current research interests are bioremediation of contaminated soil and groundwater, biofuels, and greenroofs.

Projects Available for URE18:
1. We are investigating ways to turn brewery waste into biofuel using algae.

2. Using a combination of green roofs and solar panels to increase solar efficiency while also decreasing thermal load in a building. The green roof also has impacts on water quality and quantity during rain events.

Desired preparation for this lab: Chemistry or biology knowledge will be helpful.

COMPUTER ENGINEERING

5. Dr. Yu Bai

Research Interests: Dr. Bai's research interests include neuromorphic computing, FPGA design, nano-scale computing system with novel silicon and post-silicon devices, and low power digital and mixed-signal CMOS circuit design.

Projects Available for URE18:

1. Real Time Object Detection using Artificial Intelligent

Recent research show that ours brains make vision easily. We can easily tell difference with a lion and a jaguar, read a sign, or recognize a friend face. However, these tasks are actually hard to solve with a computer. In the last few years, machine learning has made tremendous progress on addressing these difficulties. In this project, students will explore a kind of model called a deep convolutional neural network that can achieve reasonable performance on visual recognition tasks.

2. Self-driving Lego Robot using Artificial Intelligent

Recently, self-driving has been attained significant interest. In order to build a self-driving car, it requires numerous sensing equipment. For example, a standard project funded by DARPA had five different laser sensors. Therefore, current computation framework is not efficient to large scale self-driving car. In this project, students will use recent artificial intelligent techniques to construct the robot.

3. Hardware Accelerated Deep Neural Network

During recent years, researchers throughout academia and industry have been advancing the theory, operation, and applications of neuromorphic computing systems. Recent interest in neuromorphic computing systems stems from its superior and rapidly advancing performance at tasks such as image recognition, learning of complex intelligent behaviors, and large-scale information retrieval problems such as intelligent web search. However, to attain the benefits of neuromorphic computing, high computational and energy-consumption demands of the underlying processing, interconnect, and memory devices on which software-based neuromorphic computing executes has become an intense focus of government, industry, and academic research. In this project, students will focus on innovative hardware implementations to attain throughput goals within area, security, and energy constraints for orders of magnitude improvements.

4. High Performance Computing using Non-Volatile Memory (NVM)

In the past several years, the use of Non-Volatile Memory (NVM) has proven to be having a potential in solving critical challenges that exist in modern computer memory systems such as storage density, latency, and power. Currently, NVM is generated from simple analytic models and characteristics, which hinders the ability for the NVM controller to extract any visible data for real device usage. To remedy this problem, an FPGA based controller is proposed to help characterize the models from NVM that can be applied to real devices. In this project, students are using FPGA-based NVM platform for accelerating various applications such as machine learning, control system, and image processing system.

Desired preparation for this lab: No additional preparation is required. I will take the responsibility to ensure that the students have sufficient background during the summer research activities to fully benefit from their participation in the projects.

6. Dr. Kiran George

Research Interests: Bio-signal based assistive technology devices, Brain-computer interfaces, Digital wideband receivers, High-performance computing, and Pattern recognition techniques

Project Available for URE18:
Design and Implementation of Brain-Computer Interface (BCI) based Systems
A person moving mouse cursor on a computer screen is an insignificant accomplishment. But if the person is a quadriplegic controlling the cursor with nothing but brainwaves, now that would be interesting!

As part of the research, students will design and build a Brain-Computer Interface (BCI) systems. A BCI based on electroencephalogram (EEG) signals can be used to provide a direct communication channel for healthy or disabled users from the brain to a technical device. Through movement intentions brain activity can be voluntarily modulated in a predictable way. A BCI system can detect these alterations in the ongoing EEG using advanced signal processing techniques and control an application (text-entry system; prosthesis; computer game) accordingly. Since no peripheral nerves or muscles need to be involved in this process, BCI technology may be used in assistive technology for paralyzed patients. BCI systems can help surgeons, mechanics, soldiers and pilots who experience "induced disability" when hand or voice communication is infeasible. BCIs might help them request tools, navigate maps or schematics, access data, or perform otherwise difficult, distracting, dangerous, or impossible tasks.

Desired preparation for this lab: Programming experience will be beneficial.

7. Dr. Rakesh Mahto

Research Interests: My research interests include ASCI design, low power design, reconfigurable FPGA design, photovoltaics, renewable energy and mixed signal design and testing.

Project Available for URE18:
Currently, I am working on creating reconfigurable solar cells. This kind of solar cells can be used for powering micro-autonomous drones and CubeSat. You will get chance to understand the working of solar cells and learn programing of Arduino or Raspberry Pi boards.

Desired preparation for this lab: Some courses related to C and C++ programming should be sufficient.

COMPUTER SCIENCE

8. Dr. Christopher Ryu

Research Interests: Artificial intelligence and machine learning.

Project Available for URE18:
Robot programming for unmanned vehicles.
This project is about a problem of "robot navigation" using the robot operating system (ROS) for autonomous cars. The necessary background for this project includes C/C++ programming, basic physics (motion), basic math (trigonometry), and Linux operating system.

Desired preparation for this lab: C++ or Python programming and data structures.

9. Dr. Yun Tian

Research Interests: cloud computing, cloud security, big data, distributed computing, parallel and high performance computing, and computer science education

Projects Available for URE18:
1: Cloud Computing Storage Security. The rise of huge datasets, dubbed “Big Data”, have pushed the need for introducing innovative ways to provide large-scale data processing using cloud and distributed computing systems. Two popular frameworks exist today: Apache Hadoop, which uses the MapReduce paradigm, and Apache Spark, which uses the Resilient Distributed Datasets for in-memory processing. This project focuses on proposing some solutions to store data securely and at the same time process data fast by using these two frameworks.

2: Location-based services. The increase in location-based services (LBS) in recent years has raised the prominence of spatial keyword (SK) queries. As the majority of current modes of transportation require travel along roads, the use of network distances in SK queries is potentially more desirable than Euclidean distances. This project aims to propose a novel indexing method, in a distributed framework, to simultaneously return query results of all relevant points-of-interest.

3: Text Mining. Most of the data we have today is text based and difficult to analyze because of its structure and size. Text mining help many organizations to obtain valuable information from large text-based content that can provide intelligent decision making. We will study and propose a solution on text mining application to calculate the aspect rating of hotel reviews using Map Reduce.

4: Cloud Computing Network Security. Software-Defined Networking introduces centralized control logic, and separated data plane from control plane which makes it easy for network engineers to monitor traffic and diagnose threats, insert and change security policies. Customized integration will become easy. However, it also creates security challenges which didn’t exist before. In this project, we will analyze the effect of denial-of-service (DOS) attack on controller plane and propose a solution to mitigate DOS attack on SDN controller.

Desired preparation for this lab: No additional preparation is required.

MECHANICAL ENGINEERING

10. Dr. Sagil James

Research Interests: My research interests are in the areas of advanced manufacturing, smart manufacturing, 3D printing, and manufacturing process simulation.

Projects Available for URE18:
1. Improving quality of printed parts in Binder Jet 3D printing process

2. Investigation of ultraprecision laser cutting process for composites and ceramics

3. Study of vibration-assisted 3D printing processes

Desired preparation for this lab: No additional preparation is required.

11. Dr. Nina Robson

Research Interests: My research interests are in the area of Biomedical Engineering and more specifically developing technologies to aid people with physical and neurological disorders.

Projects Available for URE18:
1. Physical training of patients with reduced limb mobility using virtual reality.
The aim of this research is the development of a tool for increasing the success of training and relearning of post-stroke patients, using a new Augmented Reality Wearable Device (ARWED).

2. Design of customizable prosthetic and exoskeleton devices.
The proposed research is aimed at increasing the functionality of future prosthetic devices and exoskeletons while reducing their rate of rejection and failure.

Desired preparation for this lab: I would prefer to work with students who are interested in future mechanism design and biomedical engineering careers. Computer programming background would be useful, but not necessary.

COLLEGE OF NATURAL SCIENCES AND MATHEMATICS

BIOLOGICAL SCIENCE

23. Dr. Maria Linder

Research interests: Mammalian copper and iron metabolism, focusing on the structure, function and regulation of proteins associated with these elements. Current emphasis is on copper transport within the blood plasma (particularly a new small copper carrier we have discovered), mechanism of uptake by cells, and excretion of copper via the bile and urine, in conditions of copper overload (which naturally occurs in dogs) as well as in pregnancy and with estrogen intake/exposure. Studies use a broad variety of approaches from cell culture models, mutated mice and rats and tracer radioisotopes, to isolation, sequencing and characterization of proteins, as well as manipulation of mRNA/protein expression.

Project Available for URE18:
Determining the identity and structure of small copper carriers in the blood plasma of humans and animals.

Desired preparation for this lab: interest in biochemistry and/or chemistry

12. Dr. Merri Lynn Casem

Research interests: Biology education - Impact of student attitudes and expectations on learning. Spider silk protein - synthesis and production of spider silk fibers in the black widow spider

Projects Available for URE18:
Potential projects this summer involve developmental biology of black widow spiders, investigation of the proteins that make up the egg shell of the black widow and projects related to the histology of the silk producing glands from the spider.

Desired preparation for this lab: Students do not need specialized training to make progress in these projects.

13. Dr. Kristy Forsgren

Research interests: My lab focuses on the reproductive physiology and anatomy of internally fertilizing (oviparous) marine fishes. We are interested in characterizing the intromittent organs involved in copulation and describing sperm transfer from the male into the female reproductive system.

Projects Available for URE18:
We are currently researching two groups of local viviparous fishes: surfperches and rockfishes. These projects require considerable field work (i.e., collecting fish) and lab-based work (e.g., dissection, histology, microscopy). There is an opportunity to work with graduate and undergraduate students previously established in the laboratory.

Desired preparation for this lab: No additional preparation required. We will provide on-the-job training.

14. Dr. Nilay Patel

Research interests: Our goal is to determine how niclosamide, an FDA-approved drug, blocks cell proliferation in human cancer cell lines. We use various cell and molecular biology techniques to determine organelle functioning and signal transduction pathway activities after niclosamide treatment.

Projects Available for URE18:
URE18 student would work on the project that has advanced the most by June 2018: a) preliminary results suggest that niclosamide affects levels of kinase HIPK2, cell cycle regulator p21, and proto-oncogene b-catenin, b) Niclosamide also causes cytoplasmic acidification.

Desired preparation for this lab: No additional preparation requested.

15. Dr. Parvin Shahrestani

Research interests: We study the evolution and genetics of health-relevant traits, such as longevity and immune defense. Our lab uses a fruit fly model system.

Projects Available for URE18:
1. Understanding sex differences in immune defense against fungal infection. When flies are infected with fungal pathogens, female flies die faster than male flies. We want to understand what behavioral and genetic factors cause this sex difference in immune defense.

2. Understanding how reproduction affects immune defense. Female flies that are virgin have better immune defense compared to female flies that have previously mated. It's possible that females who have mated are allocating their resources to reproduction, at a cost to immune defense. But this has not been experimentally tested before. We want to understand why virgin females have better immune defense compared to mated females.

3. Understanding the relationship between immune defense and aging. Some studies have shown that the genes of the immune system are expressed at higher levels when fruit flies age. However, other studies have shown that older flies have worse immune defense compared to younger flies. We want to understand how aging and immune defense are related to each other. For this work, we will test for immune defense differences at different ages in the same fly population, and we will also compare immune defense differences between long-lived and short-lived fly populations.

4. Understanding the role of the gut microbes in immune defense. Previous studies have shown that the gut microbiome can affect many host characteristics, including longevity and immune defense. We will characterize, and manipulate, the gut microbiomes of long-lived and short-lived fly populations with and without fungal infection in order to understand the complex relationships among these characteristics.

Desired preparation for this lab: We will train students in all aspects of the experiments.

CHEMISTRY & BIOCHEMISTRY

16. Dr. Allyson Fry-Petit

Research interests: Research interests are in solid state inorganic chemistry, focused on the rational design of new materials through the use of data mining, synthesis, structural characterization and optical and vibrational probes.

Project Available for URE18:
Students will be researching solid materials that possess negative thermal expansion, the expansion of materials upon cooling. Their project will include synthesizing new compounds and analyzing their atomic crystal structure via x-ray powder diffraction and infrared spectroscopy.

17. Dr. Michael Groves

Research interests: We work to understand how chemical reactions take place on surfaces and develop the tools necessary to quickly and accurately predict them. Our current projects include understanding formate production from CO2 over novel metal alloy surfaces as well as hydrogen peroxide synthesis over modified graphene structures. We are also using machine learning algorithms to develop automated, and intelligent global optimization search protocols for organic systems which are designed to increase the performance of the search for thermodynamically favorable structures. We intend to use them to search for novel modified graphene surfaces.

Project Available for URE18:
Transitioning away from carbon-based fuels will be one of the major challenges facing humanity in the 21st century. During the transition, carbon neutral energy generation will useful in limiting the environmental impact of human activity while alternatives are developed. Formate is a fuel that can be synthesized from carbon dioxide and can be used to produce energy in a fuel cell. This URE18 project would focus on computationally predicting metallic alloy catalysts that most efficiently create formate from carbon dioxide. This project also involves working in tandem with experimentalist who will synthesize the predicted alloys to verify their properties.

Desired preparation for this lab: I will teach the students all the computer programming they need to work effectively in the lab.

18. Dr. Niroshika Keppetipola

Research interests: My laboratory studies the Polypyrimidine Tract binding Protein (PTB), an RNA binding protein that plays an important role in regulating the production of proteins from the genetic code in DNA (cellular gene expression). The addition of extra chemical groups to the PTB protein (chemical modification) has been correlated with uncontrolled growth in many cells, including cancer cells such as leukemia. Modifying RNA binding proteins that control mRNA composition, allows cells to regulate gene expression not only at the level of DNA but also at the level of RNA.

Projects Available for URE18:
To investigate the role of chemical modifications in RNA binding protein activity:

1. Generating mutants using recombinant DNA technology and generate mutants of modified residues.

2. Protein expression and purification using affinity chromatography.

Desired preparation for this lab: Students should have taken introductory biology and general chemistry as science courses and earned a grade of B or higher.

19. Dr. Marcos Ortega

Research interests: The Ortega lab is a biochemistry lab that focuses on viral assembly and replication. We week to study how proteins interact with each, and with viral DNA, to assemble a mature virus. The Ortega lab uses structural, kinetic, and biophysical studies.

Projects Available for URE18:
1. Large terminase expression, purification, and characterization.
In this project, students will express and purify a viral enzyme involved in viral replication. The protein will be screened for crystal formation and sent to a collaborator for further structural studies.

2. Small terminase expression, purification, and characterization.
In this project, students will express and purify a viral protein involved in binding viral DNA to initiate assembly. The protein will be used in structural studies and in DNA binding studies.

3. Capsid expression, purification, and characterization.
In this project, students will express and purify a viral protein that forms the head/capsid of the virus. The protein will be screened for crystal formation.

Desired preparation for this lab: Students should have completed general chemistry before entering the lab.

20. Dr. Andrew Petit

Research interests: Chemistry or physics; Research interests are broadly focused on using theoretical chemistry and computers to answer fundamental questions about what happens after molecules absorb light and become excited.

Projects Available for URE18:

1) Modeling the Properties of Kynurenine: Our Eye's Built-In Solar Shield.
The kynurenine molecule is found in the lens of our eye and very rapidly and efficiently transforms ultraviolet light, which could damage our eye, into harmless heat. The student will learn how to use computers to work towards discovering how this molecule does its job.

2) Using Computational Chemistry to Discover Greener Routes to New Medicines.
Many drugs contain complicated rings containing atoms other than carbon and hydrogen. In collaboration with Dr. de Lijser's research lab at CSUF, we are using computational chemistry to discover an approach to making these structures using light instead of other, less environmentally friendly, methods. This project will involve screening a series of molecules to determine patterns in how changing the structure of a molecule affects its ability to undergo the reaction.

Desired preparation for this lab: This project will be a good fit for students who are planning to major in chemistry, biochemistry, or physics. It would be good if the student has completed either general chemistry or introductory physics. Experience with organic chemistry would be useful but not necessary. Experience with calculus and/or coding are helpful but not required.

GEOLOGICAL SCIENCES

21. Dr. Joe Carlin

Research interests: My research interests are focused on coastal and shallow marine sedimentation. In particular I am interested in learning more about how the delivery of sediment from land to this environment has changed over time, what may have caused these changes, and what are the environmental responses to these changes. I typically focus on changes over the modern time period (past ~150 years) and recent geologic past (~4,000 years). I am particularly interested in understanding the role humans now play in shaping the geologic record of coastal and shallow marine environments.

Projects Available for URE18:
1: This project will analyze sediment cores collected from offshore Monterey Bay California to investigate how the supply of sediment form the land to the ocean has changed throughout time. The project offers the opportunity to assess environmental changes on land in the ocean over a variety of time scales including the recent past (last ~ 150 years) and recent geologic past (~ 3,000 years).

2: This project will determine how an urban estuary (Upper Newport Bay, CA) has evolved over the past 100 years under the influence of humans, and how future climate change, in particular sea level rise, may impact the bay.

3. This project will analyze a sediment core from a small southern California estuary (Los Penasquitos Lagoon, CA) to reconstruct the environmental changes in the lagoon over the past ~2,500 years.

Desired preparation for this lab: No additional preparation required.

PHYSICS

22. Dr. Wylie Ahmed

Research interests: Our lab is interested primarily in the field of the physics of living and/or active systems at the microscopic scale. This field is at the intersection of physics, biology, and material science and seeks to shed new light on biological processes and create new forms of “living” matter with life-like properties. Our goal is to understand the basic physics underlying biological and other active processes that make living things different from non-living. To quantify these biophysical systems we use optical microscopy, laser tweezers, high-speed imaging, and microfluidic devices.

Project Available for URE18:
1: Flow physics of active fluid droplets
The flow physics of simple liquid droplets is well understood, however how active fluids behave in similar situations is completely unknown. This project includes investigating the flow of active bacterial droplets and their shape dynamics. It involves hands on activities with microscopy, digital image analysis, and fluid physics.

Desired preparation for this lab: introductory physics, chemistry, and calculus would be helpful.

23. Dr. Leigh Hargreaves

Research interests: My research focuses on electron interactions with molecules of relevance to bio-technology. We study what happens when electrons collide with some target, looking for how much energy is left behind in the target and the deflection of the electron. These two details tell us about the "size" and "shape" of the target under study. These details, in turn, allow for sophisticated chemical modelling of the target.

Project Available for URE18:
Elastic electron scattering from levulinic acid
Levulinic acid is one of the top value-added compounds from cellulosic decomposition to form ethanol. This project will measure slow electron collision probabilities with levulinic acid, with a view to aiding chemical modelling of this target. Students will get hands on experience with a sophisticated experimental apparatus and learn skills in vacuum generation, gas handling and statistical data analysis techniques.

Desired preparation for this lab: Students should have completed 2 semesters of introductory, algebra-based physics.