Descriptions of 2019 SURP Positions available with Utica Faculty

Faculty: Asif Ahmed

Program: Civil Engineering Technology

1. **Study of the Freeze/Thaw Cycle Accurately Based on Real-time Soil Moisture and Temperature Data in Pavement Subgrade**

   In New York State, distress in pavement arises due to the freezing and thawing of the subgrade beneath pavement. The most critical seasons for highways in this state are the winter and subsequent spring thaw. The project will determine the actual timing of freezing and thawing based on the real time data provided by sensors buried beneath the soil. Accurate prediction of the depth and timing of frost and thaw can be useful for the design and maintenance of highways in frost-susceptible areas and is especially critical for low-volume roads.

   Student Skills: 1. Must be student of CE/CET who has completed Soil Mechanics on or before Spring 2019 2. Good Writing Skills 3. Competent in Microsoft Excel

Faculty: Kristina Boylan

Program: Communications and Humanities / Interdisciplinary Studies

1. **Supporting and Chronicling Utica Children's Garden Transitions**

   The Utica Unity Gardens have included a children's gardening project, attended by children from the Thea Bowman House's summer program, at their Park Avenue site since their establishment in 2013. In the past Cornell Cooperative Extension master gardeners have organized the program in conjunction with TBH, including providing two to three volunteer teachers for the children's sessions, this year the TBH and CCE will be transitioning to a summer program model taught primarily by TBH teachers and staff themselves, with periodic input from CCE and other community volunteers.

   Through Kristina Boylan's Food in Society (IDS 103) and Art and Culture (IDS 102) classes, SUNY Poly has supported this program since 2014. Dr. Boylan would like to support this program's transition in two ways, and seeks a student interested in participating in both aspects of the project. First, we will coordinate with the TBH staff and CCE to collect, archive, and produce materials that can be used and adapted for this and future years' summer garden programs; this will include time spent in the garden to learn about its foundations, needs, and processes, so a willingness to get one's hands dirty is a must. The second aspect also will involve willingness for community engagement; this moment of transition is an opportune time for participants to reflect on the experience of the creation of the children's program and the larger Utica Unity Gardens. My goal is to design and propose an oral history project of the garden to its participants, and to explore methods of the ethical preservation and diffusion of the interviews (e.g. with the Oneida County History Center, Soundcloud oral history projects, etc.), as a preparatory step

toward undertaking it and, again with permissions, writing/publication projects based upon it (e.g. for academic journals like Gastronomica and Global Food History, sound projects like The Keepers (http://www.kitchensisters.org/keepers).

Student Skills: Ideally, the interested student will:

• Have an interest in gardening and DIY food production, and gain or increase familiarity with research and discussions of its past, present, and future.

• Have taken IDS 103 Food in Society or otherwise have a high degree of familiarity with gardening and/or other seed-to-harvest group projects (experience in FFA, 4H, hobby farming and similar experiences also considered).

• Have an interest in history and historiographic issues, and a willingness to learn more about oral history methods (including interviewing, recording, and archiving) and requirements (gain or increase familiarity with privacy and shared authorship discussions, and additional training as necessary if the project reaches the stage of actual interviewing).

Faculty: Mark Bremer

Program: Biology

1. **Green Building Certification Documentation**

   Research involves working with faculty and facilities staff to compile and prepare documents to support new applied learning courses focused on certifying existing campus green buildings. Additionally, student researchers have an opportunity to earn a green building industry-specific credential, such as LEED Green Associate.

   Student Skills: Interest in sustainability principles, such as water & energy efficiency, renewable energy, waste reduction, indoor air quality, occupant health, and green cleaning. Background in science and/or engineering is a plus.

Faculty: Chen-Fu Chiang

Program: Computer and Information Science

1. **Quantum pseudo-random number generators**

   Using a well-studied quantum algorithm running on various structures such that the sequence generated from iterations of various final amplitudes can guarantee certain high degree of randomness. 1. Determine the best structures for the algorithm and seek a possible connection (function, parameterize) with respect to the structure and the degree of randomness. 2. Find the best compromise between structure and efficiency.

   Student Skills: 1. matrix linear algebra 2. python programming skills and matlab 3. write paper in LaTex 4. capable of dealing tons of generated data and corresponding analysis (compute the degree of randomness from the generated amplitudes)

Descriptions of 2019 SURP Positions available with Utica Faculty

Faculty: Andrea Dziubek

Program: Mathematics and Physics

1. **Structure Preserving Numerical Methods for Partial Differential Equations on Curved Surfaces**

   Exterior calculus, developed by Cartan several decades ago, has become the standard language of differential geometry and has gradually been gaining acceptance as the superior formulation of vector calculus in scientific and engineering community. Building on the foundation of modern differential geometry and in particular exterior calculus, geometric mechanics reformulates mechanics, in particular Lagrangian and Hamiltonian mechanics, in the language of geometry. Formulating the problems in the language of geometrical mechanics has enabled researchers to develop new numerical methods, which preserve geometrical structures.

   Students will work with faculty on one or more of the following:
   a) Comparing Discrete Exterior Calculus and Finite Elements for exemplary problems.
   b) Understanding the discrete divergence operator and other operators of the basic equations of fluids, mechanics, and electromagnetism.
   c) Implementing discrete exterior calculus routines for problems on curved surfaces.
   Student Skills: Student Skills: Preference will be given to students who mastered multivariate calculus, linear algebra, differential equations, and a programming language, preferably Python.

2. **Mathematical Modeling of Blood Flow in the Retina of the Eye**

   The Mathematical Modelling Lab at SUNY Poly, Utica, specializes in the development, analysis and verification of mathematical models and the current focus is on modelling the blood flow in the retina of the eye. For example, our physically based modelling, based on first principles, coupled with the most advanced analytical and numerical solution techniques, has predicted that changes in the curvature of the retina of the eye lead to significant changes in the blood flow, which in turn may play a significant role in primary open- angle glaucoma. http://people.sunyit.edu/~edmond/EyeDEC/

   The blood flow in the retina of the eye is modelled as a Darcy flow through a hierarchical porous medium and is described by the parameterized Darcy equation. This equation is similar to the traditional Darcy equation, which can be used for example to model the flow of water or oil through sand, but it is extended by an additional variable, which represents the various blood vessels: large arteries, small arteries, arterioles, capillaries, and the various size veins. In other words, the model describes not only the spatial flow, but also the hierarchical flow, from arteries, through capillaries, to veins.

Student Skills: The student will have the opportunity to participate and to contribute to all aspects of the project and to focus on one particular area of their choice, appropriate to their level. The prerequisites are a solid background in mathematics, minimally at the level of calculus, and preferably including linear algebra, differential equations and multi-variable calculus, familiarity with a programming language, preferably Python, and an interest in applied mathematics, including mathematical modelling and scientific programming.

Faculty: Lauren Endres

Program: Biology and Chemistry

1. **Translational regulation of the cell's response to oxidative stress**

   Several ongoing projects aim to understand how cells respond to oxidative stress, and how these mechanisms "go awry" in cancer. My lab uses both yeast and cancer cells to understand how the stress response is conserved among eukaryotes. Research this summer will explore the function of genes that are targets of translational regulation after exposure to toxicants such as hydrogen peroxide, arsenic, and rotenone.

   Student Skills: The summer intern should have a strong foundation in biology, having completed freshman biology with at least a B+ average. Also, basic skills using Microsoft Excel for statistical data analysis (i.e., graphing mean and standard deviation) would ensure a highly successful research experience.

Faculty: Sivapalan Gajan

Program: Civil (Geotechnical) Engineering

1. **Development of Predictive Algorithms for the Performance of Foundations during Earthquake Loading**

   The accurate prediction of nonlinear-cyclic stress-strain behavior of foundations during earthquake loading is an essential component of seismic design of buildings and bridges. A database, consisting of results obtained from centrifuge and shaking table experiments conducted all over the world, has been created and is available at https://datacenterhub.org/ (managed by Purdue University). The objective of this summer project is to extract valuable experimental data on key capacity, demand, and performance parameters of foundations during dynamic base shaking loading. This also includes data processing to obtain meaningful processed data from raw experimental data.

   Eventually, these processed data sets will be used to calibrate (train) and validate (test) machine learning algorithms that may be used as predictive tools for the performance of foundations during seismic loading (this last component is not part of the summer project,

but a possibility for the student to continue research as an independent/individual study course).

Student Skills: Sophomore or junior standing in engineering or computer science, basic math background, basic skill in computer programming (e.g., Matlab or Mathcad), and proficiency in Excel.

Faculty: Andrew Gallup

Program: Psychology

1. **Heritability and reproductive correlates of aggression in water striders**

   This project will examine differences in aggressive behavior among water striders to assess the degree to which variability in this trait is passed down to offspring and impacts reproductive success of individuals. Insects will be acquired from local streams and transported into the laboratory, where controlled experiments will be conducted. Data will be acquired through a combination of continuous and focal sampling.

   Student Skills: Willingness to handle and work with insects is a must. Field and laboratory biology research experience is preferred, but not necessary. The student working on this project must be detail-orientated.

Faculty: Iulian Gherasoiu, *research will take place in Albany*

Program: Electrical Engineering Technology

1. **Resilient Water Splitting Cell for Hydrogen Generation**

   Most of the photoelectrochemical (PEC) cells have a surface that is easily oxidized and corroded affording a lifetime of only a few hours before the hydrogen generation stops. The project continues the development of a corrosion resistant and efficient PEC water splitting cell having the ability to spontaneously dissociate water under solar AM1.5 illumination.

   Student Skills: Knowledge of general physics for engineering students, including Electricity, Magnetism and basic notions of Solid-State physics. Knowledge of general chemistry.

2. **Resistive Switching Solid Electrolyte Memory Cell**

   Resistive switching memristors are promising to enable various applications as nonvolatile memory devices that are extremely small, simple and do not require power to maintain information. This project aims to develop and optimize a metal-oxide/silicon dioxide device, compatible with silicon processes, and will analyze its reliability and operational lifetime.

   Student Skills: Knowledge of general physics for engineering students, including Electricity and Magnetism and basic notions of solid-state physics. Knowledge of general chemistry.

3. **Semiconductor Device Modeling using COMSOL or similar software**

   Optimization of the operation of electronic devices relies on the ability to model realistic 2 or 3-dimensional semiconductor devices and simulate their operation under pre-determined conditions. Using COMSOL or a similar multiphysics software platform, a model for the operation of Field Effect Transistors (FET) and photoelectrochemical cells (PEC) fabricated using oxide-based and carbon-based thin film materials will be created. The operation of the devices will be simulated using a defined set of material parameters, voltage biases and other external excitation. The goal of the simulation is to determine the material parameters that allow the optimal operation, the effect on the device response caused by deviations from the optimal material parameters and by the changes of the voltage bias or external excitation.

   Student Skills: Knowledge of general physics for engineering students, including Electricity and Magnetism and basic notions of solid-state physics. Knowledge of general chemistry. Familiarity with COMSOL multiphysics software, or alike desired.

Faculty: Naser Haghbin

Program: Mechanical Engineering Technology

1. **Bio-3D Printer**

   3D printing technology are becoming more versatile and more accessible than ever before. One of the printing technologies that is growing in popularity the most is the bio 3D printer, which is used for relatively soft materials (e.g. PDMS and gels) to create micro-fluidics devices and tissues. The objective of this research project is to design and build a bio-3D printer and create the samples using this technology.

   Student Skills: Familiar with the 3D printing

2. **Two Phase Thermal System at the Center for Global Advanced Manufacturing (CGAM)**

   This thermal system will be designed and fabricated for cooling micro-electronic devices (e.g. cold plate and heat sink) using facilities located in the Center for Global Advanced Manufacturing at SUNY Poly, such as 3D printers and CNC machines.

   Student Skills: Familiar with Heat Transfer and SolidWorks, Worked with lathe and mill machines

3. **Micro-channel machining using Laser and AWJ**

   Abrasive water jets and fiber laser machining are two advanced machining processes available at CGAM, SUNY Poly. In this project, student investigate and compare quality of micro-features created by these two method.

   Student Skills: CNC machining, Solid Works

Descriptions of 2019 SURP Positions available with Utica Faculty

Faculty: Daniel Jones

Program: Mechanical Engineering Technology

1. **Analysis of Electroencephalography (EEG) Data**

   We are collecting EEG data from 80-100 student participants in the newly-established EEG laboratory. Signals are measured with 256 sensors at 1,000 Hz while participants provide emotional response to photographs. This project aims to analyze the data to understand neural activity of the brain in response to the images.

   Student Skills: General computer skills for analyzing data, particularly in MATLAB or related programming environments.

Faculty: Hisham Kholidy

Program: Network and Computer Security

1. **SCADA System Security**

   The SCADA cyber security is one of the key research areas. The proposed project specifically contributes toward the need of advanced tool to identify the abnormal behavior across the large SCADA systems such as the Cyber Physical Power Systems (CPPS) in a scalable way. Prospective students have wide scope to select a topic within this field. Some areas of current research activity include: intrusion detection (IDS) and situational awareness (combination of IDS and Threat Intelligence); simulation and machine learning techniques; cyber-physical system interaction and HMI vulnerability; and developing a new data reduction approach to select the important features from the SCADA input data.

   Student Skills: Required: (1) Programming Skills (Java, Python). (2) Basic Computer Network Experience. Recommended: (1) Penetration Testing. (2) Machine Learning Approaches

Faculty: Zhanjie Li

Program: Civil (Structural) Engineering

1. **CUFSM Usability Enhancements for Elastic Buckling Analysis on Members with Holes**

   Design provisions of members with perforations are covered in Chapter E for compression members and Chapter F for flexural members in current AISI specifications. While AISI specifications indicate any numerical elastic buckling solution that includes the relevant mechanics for the buckling mode under consideration is permitted to be utilized, the freely available program, CUFSM, has gained wide popularity. For members with perforations, approximate numerical methods incorporating CUFSM have been developed for finding the local, distortional, and global elastic buckling modes of members. However, the current module for hole effect analyses demands significant

input information from the user and also requires the user to be well-informed with both the provisions and the CUFSM program to use it. Simplified inputs and direct outputs of the elastic buckling information of the relevant buckling modes are desired. An improved and user-friendly module of CUFSM for evaluating the hole effect will be developed to aid the efficiency of the analysis and design of member with holes. Then, relevant design examples on how to utilize the module for design will be developed and design tables for typical members with holes will be developed as well for design guidance.

Student Skills: Student should be familiar with structural analysis, MATLAB coding, and Excel.

Faculty: Vijay Ramalingam

Program: Chemistry

1. **Design and synthesis of interlocked organic molecules**

   Rotaxanes are class of Interlocked molecules in which a linear long chain molecule threads a macrocyclic cavitand, which is sterically hindered on the terminals. Due to the dynamic nature of these molecules and permanent interlocking without covalent linkages, they have potential applications in the design of molecular switches, machines, and nano muscles. Even though many novel synthetic routes have been demonstrated for synthesis of such structures involving classical organic transformations, very few methods are known that involves aqueous media. Designing synthesis and establishing function of rotaxanes in aqueous media is important if biological applications of rotaxanes are to be realized.

   Student Skills: Completion of organic chemistry1 (CHEM230T @ SUNY Poly)

Faculty: Michael J. Reale

Program: Computer Science

1. **Deep Learning for Automatic Facial Expression Analysis on 2D and 3D Dynamic Data**

   Automatic machine understanding of facial expression behavior has many applications in a wide variety of fields, including education (e.g., automatic tutoring), industry (e.g., advertising, gaming), medicine (e.g., pain detection, human-computer interfaces), and military/law enforcement (e.g., airport security, lie detection). However, there are also many challenges to overcome, including unpredictable lighting conditions, non-frontal head pose, occlusion issues, and “micro-expression” behavior. In this project, we propose to utilize deep learning approaches on dynamic 2D and 3D face data to automatically analyze expressive behavior.

   Student Skills: Required: Python programming experience. Preferred: machine learning experience, computer vision experience, C++ programming experience

2. **Fundus image segmentation and analysis**
   The goals of the project are to perform image segmentation on the arteries and veins from fundus (back of the eye) images, build a 3D mesh of aforementioned vascular structures, and perform analysis as well as simulations from this information. We will explore deep learning approaches to accomplish some of these goals.
   Student Skills: Required: C++ and Python programming experience. Preferred: machine learning experience, computer vision experience.

Faculty: Carolyn Rodak

Program: Civil (Environmental) Engineering

1. **Microbial source tracking (MST) and fecal indicator bacteria in the Mohawk River**
   The overall goal of the work is to identify baseline and augmented water quality conditions within the Mohawk River in the Utica / Rome NY region. Of particular interest is the ability of the river to return to its baseline state after disturbances such as combined sewer overflow events. To quantify this resilience, we will continue an intensive summer field sampling campaign which started in the summer of 2016 focused on general water quality parameters and the presence of microbial indicators of fecal contamination. When not in the field, students have the option to explore other facets of the work depending on need, skillset, and student interest including but not limited to: quantitative polymerase chain reaction (qPCR) for MST, quantitative microbial health risk assessment, ArcGIS and watershed mapping, water sampling drone design, and machine learning for MST prediction.
   Student Skills: Previous experience with field work not required but will include hiking / walking through wet and rough terrain. Experience with excel, MATLAB, SPSS, or GIS a plus.

Faculty: Edmond Rusjan

Program: Mathematics and Physics

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Faculty: Jiayue Shen

Program: Mechanical Engineering Technology

1. **Self-powered wireless sensor system for structural health monitoring**

Structures, such as buildings, highways, bridge, and aircraft, et al., are expected to perform its designated functions. However, existing road monitoring solution demands a certain periodic maintenance effort due to battery life limits in the sensor systems. To detect the problem timely and take necessary action accordingly, there is an urgent need to structure monitoring systems that can automatically and quantitatively analyze the real-time condition of structures. To this end, we are interested in developing a self-powered wireless sensor to monitor the structural health continuously. The student will help with fabricating and testing the sensor system.

Student Skills: Preference will be given to the student who has a strong background in electronics and basic knowledge of Labview and Matlab.

Faculty: Shuang Tang

Program: Mechanical Engineering

1. **Finding New Multilayer 2D Materials**

   For electrical and optical applications, we are interested in discover new multilayer 2D materials, such as graphene, tellurene, black phosphorene, etc. This project will require students create new possible atomic structures under the instruction of the professor, and find the electrical and optical properties of the new structure, aiming to publish papers in academic journals.

   Student Skills: Students who have taken the fundamental courses in physics and introduction to materials science, and is interested in studying structure and properties of new materials.

Faculty Ali Tekeoglu

Program: Network Computer Security

1. **Network Defense through Dynamic Attack Surfaces**

   Current information system defenses (at the network, host machine, and lower levels) are static, keeping the same configuration over time with little or no change. Consequently, attackers may perform reconnaissance at their own leisure and launch attacks when they are ready. In response to this situation, a new class of defenses has been developed, called Moving Target Defenses (MTDs; also called cyber agility techniques). MTDs dynamically change the configuration of defenses and/or target machines over time, thus shortening the reconnaissance/plan/attack cycle available to the adversary. In this research project, we are going to develop open-source tools for Moving Target Defense algorithms to protect Virtual Machines in a cloud environment.

   Student Skills: Python, Bash (Linux scripting), basic networking, cloud computing (aws/azure/google-cloud)

Descriptions of 2019 SURP Positions available with Utica Faculty

Faculty: Xia Yang

Program: Civil (Transportation) Engineering

1. **Data-driven winter road snow-ice removal**

   This project will focus on the optimization of winter road snow-ice removal especially in Oneida County, NY. Major research will be conduct on:

   (1) Collecting and analyzing data about current operations, and building an evaluation matrix;

   (2) Conducting cost-benefit analysis of each material and proposing a material selection framework;

   (3) Optimize the routing of winter-snow removal operations as well as the salt spreading rate.

   The student will help with the data collection and analysis, which will be collaborated with NYSDOT

   Student Skills: Students should be familiar with one of the tools: Excel, or Matlab, or Python. The latter two are preferred.

Faculty: Yu Zhou

Program: Mechanical Engineering

1. **Force control of robotic composite layup process**

   This project will research the force control for a robotic composite layup process, in order to accomplish consistent and uniform robotic layup of composite materials. Real-time feedback of the contact force between the robot and material will be taken. A force control approach will be studied and programmed. Experiments will be carried out to test and adjust the control approach.

   Student Skills: Robot programming with Python or MATLAB