# Descriptions of 2019 SURP Positions available with Utica Faculty

## 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)

## 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.

# Descriptions of 2019 SURP Positions available with Utica Faculty

## 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: 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: 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

**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: 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 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 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)

## 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.