NYU Tandon School of Engineering Presents
The 11th Annual Undergraduate Summer Research Program

The NYU Tandon School of Engineering is pleased to announce the 11th Annual Undergraduate Summer Research Program. This program supports summer research internships with mentorship from Tandon faculty. These selected undergraduate students will have the opportunity to get involved in this cutting-edge research for 10 weeks, June 5th - August 11th 2017. The positions are paid at $12 per hour for full-time work up to 35 hours per week. In addition to their work in the lab, students will attend seminars put together by faculty, staff, and invited speakers as well as have the opportunity to present their own research to their peers.

The range of research projects in which students may participate in is quite diverse. Applicants are encouraged to find out about available research projects in their areas of interest from the list below. For further information on a particular project or area of study, please contact the research mentors directly. The paid research assistantships are only available for those projects listed below.

Eligibility:

Eligible students must be an NYU undergraduate student from the Tandon School of Engineering, NYU Abu Dhabi, NYU Shanghai, or the SOE-CAS 3+2 Program. Undergraduate students from other universities can also apply for the program, but they must do so through the Summer Research Program for College Juniors. All students must be in rising sophomore, junior, or senior class standing and have a minimum cumulative GPA of 3.0. Students who will graduate in May 2017 are ineligible to apply for this program. As this is a full-time position, students cannot have another job or internship or take classes that conflict with work hours, unless preapproved by their research mentors. Please note that some projects have special requirements for participation; please refer to the project listing for those project specific requirements.

Application Process:

NYU applicants must apply using the online application portal located on the Tandon School of Engineering Undergraduate Summer Research Program webpage: http://engineering.nyu.edu/research/undergraduate.
If they meet the eligibility requirements, non-NYU undergraduate students must apply online through the Summer Research Program for College Juniors webpage: http://engineering.nyu.edu/summer_research).
Completed applications are due on Sunday, February 12th 2017 at 11:59pm EST. Neither late nor incomplete applications will be accepted.

Fellowship Information:

All female applicants will automatically be considered for the Thompson-Bartlett Fellowship and all NYU Tandon Honors Program students will automatically be considered for the Honors Program Fellowship.
2017 Undergraduate Summer Research Program Projects:

APPLIED PHYSICS

Professor Vladimir Tsifrinovich  
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Research Project:  
• Motion of Galaxies in Expanding Universe  
  Theoretical computations based on general relativity and analysis of astronomical data.

CENTER FOR URBAN SCIENCE AND PROGRESS

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Brittney O'Neill – brittney.oneill@nyu.edu  
Ravi Schroff – ravi.schroff@nyu.edu  
Stanislav Sobolevsky – sobolevsky@nyu.edu  
Juan Bello – juan.bello@nyu.edu  
Ivan Selesnick – iws211@nyu.edu

Research Projects:  
• New Indexes for Aerial Remote Sensing Data  
  Data storage is essential especially in aerial remote sensing as typical data sets new exceed 1 TB/km2 and commonly contain billions of points. Yet the storage strategies (i.e. data indexes) are generic in nature having been designed for many data types and do not consider user needs for manipulating aerial remote sensing (ARS) data. This project will implement two new data indexes specifically designed for ARS data and how those data are used. The summer researcher will learn cutting edge techniques working with the world’s densest urban aerial laser scanning dataset (>335pts/m2 for Dublin Ireland). Basic programming skills are needed for this project.
• Statistics Based Rapid Change Detection for Remote Sensing Data  
  Current strategies to do rapid change detection on aerial remote sensing (ARS) data suffer from many problems including incompatible data granularity, vegetation-based interference, and computational expense. To overcome these, this project will look at deriving simple statistics as a means to rapid comparison of small geographic areas (e.g. 100 m2). Key factors will relate to determining the best statistical predictor and determining minimum data densities and ideal geographic extents. The summer researcher will learn cutting edge techniques working with the world’s densest urban aerial laser scanning dataset (>335pts/m2 for Dublin Ireland). Basic programming skills are needed for this project.
• Building Inspection Data Integration  
  NYC requires all buildings 7 stories or more to undergo facade inspection every 5 years. While the outcome of the inspection is reported through a municipal website, the valuable information with respect to the actual images remains largely inaccessible as it is only available through in person inspection at the Department of Buildings. This project would create a mechanism for the storage and temporal exploration of the data (e.g. see how a crack might grow from inspection to inspection). Basic programming skills are needed for this project.
• Sonification of Aerial Remote Sensing Data
Putting sound to non-tonal is an established technique that has yet to be applied in a systematic way to remote sensing data. However, initial work in this area seems highly promising. In this project, the summer researcher would learn standard sonification and filtering techniques and apply them to dense aerial remote sensing (ARS) data sets to determine if this approach can be employed for rapid object detection in large, urban laser scanning data sets. Success in this area would lay the framework for a semi-automated training mechanism for machine learning. Strong programming skills are needed for this project that will be a collaboration between Prof. Debra Laefer and Prof. Juan Bello

- **Sparse Deconvolution of Full Wave Form Data**
  A full wave form version of aerial laser scanning (which includes all the back scatter energy) has been commercially available since 2004, yet to date attempts to process the data using something other than Gaussian deconvolution have been highly limited. Preliminary efforts to apply signal processing techniques have already brought unprecedented results (e.g. improved accuracy by an order of magnitude, 15 cm recurrence vs 60 cm). This project would continue efforts in this area as a collaboration between Prof. Debra Laefer and Prof. Ivan Selesnick. The best-suited student for this project would be from Electrical Engineering or Mathematics

- **Soundless Chemical Demolition Agents**
  Soundless chemical demolitions agents (SCDA) provide a non-percussive alternative to jack hammers and explosives. While commercially available since the 1970s, this class of products has only enjoyed modest industrial uptake, in part due to an absence of rigorous usage guidelines. To help fill this gap, this project will reanalyze two dozen large-scale demolitions (mostly done 2001-2004) in light of newly published research related to expansive pressure as a function of hydration heat and ambient temperature. The summer research student would have an ideal opportunity to learn about a set of highly useful specialty products. This project would be well suited for a Civil or Mechanical Engineering student, although others (including non-engineers) would be welcome. Only a working knowledge of excel is needed. Younger students are especially encouraged to apply.

**CHEMICAL AND BIOLOGICAL ENGINEERING**

Professor Kesava Asam  
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**Research Project:**

- **Staff of Gandalf**
  The electronic transport aid for the visually impaired will be further developed to create a working prototype. This prototype will include an array of sensors that is able to signal to the user if there are any obstacles ahead. Improvements will be made to the design of the prototype to enable the visually impaired to navigate their surrounding environment more easily.

- **Simulation of Origins of Life**
  Students will work to understand the intricacies of amino acid linkage and protein folding to create a computer simulation of how amino acids combine to create fully functioning enzymes. The simulation will model the formation of proteins from amino acids and the way in which separate amino acids can come together to form much longer chains that eventually make up enzymes that are able to perform specific functions. Beginning with simple amino acids, the formation of much more complex proteins will be tracked by observing the interactions between side-chains of amino acids formed at set intervals.
• **Dash Cam**
  The goal of this project is to create an application for devices that is able to display content from both cameras simultaneously. This will allow phones with both front and back cameras to be used as dash cams where a portion of the screen displays what is seen in the front camera, and another portion displays what is seen in the back camera. *Note: Preference will be given to students with a minimum GPA of 3.0 who have coding and electronics experience.*

**Professor Mary Cowman**
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**Research Project:**
• Bioanalytical Chemistry of Extracellular Matrix Glycosaminoglycans
  Development of methods for isolation, analysis, and enzymatic modification of glycosaminoglycans. The project is relevant to understanding and diagnosis/prognosis of disease states. *Note: Preference will be given to students with a minimum GPA of 3.5, lab experience, and evidence of leadership.*

**Professor’s Bruce Garetz & Janice Aber**
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**Research Project:**
• Effect of Gold Nanoparticles on Laser-induced Nucleation
  Gold nanoparticles exhibit plasmon resonances that can enhance the strength of electric fields. We propose to test whether the threshold for laser-induced nucleation is reduced in the presence of gold nanoparticles.
• Laser-induced Nucleation in Millimeter-sized Dense Liquid Droplets
  A focused continuous-wave laser beam is capable of forming a millimeter-sized droplet that is highly supersaturated in solute, but such a droplet will not spontaneously nucleate unless it is moved to the solution-air interface. We propose to determine whether such a droplet will nucleate when exposed to a nanosecond pulsed laser beam.
• Characterization of Block Copolymers for Lithium Battery Application
  We use light scattering to study the micrometer-scale grain structure of block copolymer materials, in an effort to understand how this structure affects the conductivity of polymer/lithium salt mixtures that can be used as lithium battery electrolytes.

**Professor Ryan L. Hartman**
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**Research Project:**
• Flow Chemistry with Microchemical Systems
  Dr. Hartman’s laboratory investigates flow chemistry with microsystems using catalysis and reaction engineering principles. Our contributions impact the design of processes and systems, ranging from the molecular-to-the-macro- length scales. Continuous-flow manufacturing, flow chemistry, and microchemical systems are major themes of our laboratory. Applied mathematics are essential in each area in order to derive predictive models that impact society. The research project will be in collaboration with a doctoral student investigating the design of microreactors to understand asphaltenes, methane, or DNA science. Flash crystallizations in microreactors might also be studied. *Note: Preference will be given to junior level students in the top 10% of their class with previous experience working with chemicals in a laboratory.*
Professor Jin Ryoun Kim  
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Research Project:  
• Amyloid Aggregation in Neurodegenerative Diseases  
  Students will engineer an amyloid aggregation system for controlled protein assembly or detection of aggregates.

Notes: Preference will be given to students with a minimum GPA of 3.3.

Professor Tommy Lee  
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Research Projects:  
• Dead Man Walking  
  Many senior citizens that are living alone feel uncomfortable with being monitored to make sure they are safe, which can pose to be a major issue not only for themselves, but also for those who care for them. The goal of the Dead Man Walking project is to develop a non-intrusive method to ensure that whenever an elderly person gets into an accident, the appropriate people will be notified. This will allow those people to ensure that whoever they are caring for are not in any danger.

• Panic Button  
  The Panic Button is a project aimed to develop methods through which large groups of people can be notified of emergency situations quickly. These methods will be evaluated to find the safest and most efficient method to accomplish the task of rapid information dissemination. An application will be made in order to accomplish these goals.

• Chemtris III  
  Topics in organic chemistry and biochemistry will be used to build the next level of Chemtris. In Chemtris I, chiral forms were used to understand rotation of molecules. In Chemtris II, concepts of chemical bonding were introduced, along with more complex chiral forms. In Chemtris III, the concepts of hydrophobicity and hydrophilicity will be developed, and additional chiral forms will be included. Players will gain better knowledge of chemistry through visual representation of molecules and gaming.

Notes: Preference will be given to students with a minimum GPA of 3.0 who have coding experience.

Professor Rastislav Levicky  
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Research Project:  
• Effect of Electric Fields on DNA Hybridization  
  Students will work on understanding how to control interactions between nucleic acid molecules with electric fields, with applications to biosensors and nucleic acid diagnostics.

Notes: Preference will be given to students who have completed CM-GY 5040 and Chemical Laboratory Safety.

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Research Projects:  
• Protein Engineered Biomaterials for Treating Osteoarthritis (OA)
Students will be able to express, purify and characterize engineered protein biomaterials to deliver a protein therapeutic for OA treatment.

- Magnetic Protein Engineered Fibers for Magnetic Resonance Imaging (MRI)
  Students will be able to express, purify and characterize engineered protein fibers bearing iron oxides for magnetic resonance imaging.

- Engineered Phosphotriesterases (PTEs) for Detoxification of Pesticides
  Students will be able to express, purify and characterize engineered PTE variants for degrading pesticides.

Note: Preference will be given to students who have completed biology and organic chemistry and have a minimum GPA of 3.0.

Professor Alexandra Seidenstein
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Research Project:
- Molecular Nutrition Lab Development
  Students will design and execute laboratory experiments that will be implemented in a new Molecular Nutrition course. Students who take this course will be able to understand the role of biologically important molecules in the various mechanisms of the human body. After the designs are complete, students will then test the experiments to ensure that they produces the expected results

- Model of Neurons and Bone
  Typically, models of neurons and bone do not have enough detail to provide students with adequate information to visualize tissues on a microscopic level. Students involved in this project will couple CAD and 3D printing to build models of neurons and bones to be used in the Anatomy and Physiology Labs. Previous models will be further developed by students to create a more accurate and scaled model of neurons and bones

- Model of Skeletal Muscle
  Many of the models sold today for anatomy and physiology lack the details to clearly visualize the molecular world. Students will couple CAD and 3D printing to build models of skeletal muscles to be used in the Anatomy and Physiology Labs. Students will also develop previous models further to create a more accurate and scaled model of the muscle

CIVIL AND URBAN ENGINEERING

Professor Joseph Chow
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Research Projects:
- Evaluating Market of Multiple Providers of Mobility as a Service (MaaS)
  In this project, a student is needed to help collect data and run computational experiments involving simulation of on-demand transit fleets acting in competition or cooperation. Under what conditions are cooperation more natural for service providers like Via, Car2Go, etc.? What mechanisms for cooperation are more effective, e.g. fare bundling, service leasing? This work is in support of an NSF funded grant CMMI-1634973.

- Real-time Transit Analytics for NYC
  With the abundance of real-time transit system data available in NYC, as well as potential new data with their upgrades in automated fare collection, it is more important than ever to be able to develop tools for large-scale computation of transit level of service or accessibility. A student will help implement this system and a learning
mechanism to update information based on individual vehicle trajectories using inverse optimization.

Notes: Preference will be given to second year students with an interest in civil infrastructure and/or transportation systems with some basic background in programming.

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Research Projects:

• The Qualified Community at Hudson Yards
  The Quantified Community (QC) – a long-term neighborhood informatics research initiative – is a network of instrumented urban neighborhoods that collect, measure, and analyze data on physical and environmental conditions and human behavior, in order to provide a rich resource for better understanding how neighborhoods and the built environment affect individual and social well-being. The QC was initially launched in three very distinct neighborhoods in New York City: at Hudson Yards, an under-construction “city-within-a-city” of 28 million square feet in Manhattan; in Lower Manhattan, a mixed-use neighborhood that attracts residents, workers, and visitors; and in Red Hook, Brooklyn, an economically-distressed community facing significant development and demographic changes. The proposed research involves the development, calibration, and field deployment of environmental sensor arrays at the Hudson Yards development in New York City. Our urban sensors have been developed to measure and track localized environmental conditions (air quality, noise, luminosity, temperature/pressure/humidity) at high spatial and temporal resolution. Students will work with the Quantified Community research team to deploy these sensors and analyze data generated to gain insights into urban sustainability and resilience at the district scale

• Data Driven Urban Energy Modeling for Policy and Planning
  The reduction of energy use and greenhouse gas (GHG) emissions in the urban built environment has emerged as one of the primary grand challenges facing society in the 21st century. For instance, New York City has established an aggressive mandate to reduce GHG emissions from 2005 levels by 80% by 2050. Other cities in the U.S. and internationally have adopted similar goals, including Los Angeles, Chicago, Boston, Philadelphia, Austin, London, and Tokyo (Kontokosta 2011, 2013, 2015). According to the U.S. Department of Energy (DOE), the U.S. buildings sector accounts for 40% of GHG emissions and energy use, a sizeable figure that is most pronounced in cities: in New York City and Chicago, for example, buildings account for 79% and 71% of all energy use, respectively (City of New York 2012; City of Chicago 2014). As a result, major cities have adopted significant building energy efficiency and GHG reduction plans to not only address issues of climate change and sustainability, but also to stimulate economic growth, encourage technology innovation, and mitigate potentially negative economic, environmental, and public health impacts. To achieve these goals, new data-driven methodologies are needed to identify and target efficiency opportunities in the built environment at the building, neighborhood, and city-scale. This project involves close collaboration with the NYC Mayor’s Office of Sustainability to analyze building energy data for more than 23,000 buildings and energy audit data for more than 5,000 buildings to develop targeted approaches to energy efficiency in the buildings sector.

COMPUTER SCIENCE AND ENGINEERING
**Professor Justin Cappos**
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**Research Projects:**
- **Uptane; Securely Updating Automobiles**
  Cars today use a truly enormous amount of software. Like any software, this software has bugs. Unfortunately there is not a secure way to update the software in cars today. Our Uptane project provides a mechanism to securely distribute updates to cars. Uptane can counter a comprehensive array of security attacks, and is resilient to partial compromises, while addressing automotive specific vulnerabilities and limitations. Students are expected to have good programming skills. Visit [https://uptane.github.io/](https://uptane.github.io/) for more information.

- **PolyPasswordHasher (PPH): Crack that Password? Not in a Million Years…**
  PolyPasswordHasher is a secure password storage system that's highly resilient to offline password cracking. It achieves this resilience by using Shamir Secret Sharing and other cryptographic techniques to introduce asymmetry in the effort that servers require to verify passwords, and crackers require to crack them. Students are expected to have good programming skills and reasonable math skills. Visit [https://polypasswordhasher.github.io/PolyPasswordHasher/](https://polypasswordhasher.github.io/PolyPasswordHasher/) for more information.

- **Sensibility Testbed: Harnessing the Power of Smartphones for Science!**
  Given the close proximity of smartphones to users, researchers across many different fields would benefit from accessing smartphone sensors. By giving the user control over what amount and type of data can gathered, Sensibility ensures the security of user information and the safety of the device, while giving researchers access to information that would otherwise be difficult to collect. Students are expected to have good programming skills, especially in Android or Python. Visit [https://sensibilitytestbed.com/](https://sensibilitytestbed.com/) for more information.

**Professor Haldun Hadimioglu**
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**Research Project:**
- **Exploring New Types of Computing**
  Traditional computing utilizing one or more processors (cores) on microprocessor chips is no longer satisfactory for a number of applications (apps). Because, it is too slow : It implements apps via software. New chips, reconfigurable chips (field programmable gate array, FPGA, chips) implement apps via hardware, offering an attractive alternative : They run at much higher speeds. Recent FPGA chips have cores on them, making them more flexible : An app is part hardware and part software. Using such powerful chip is becoming easier on new development+run-time platforms : One develops Python/C/C++ programs, running fast on them. The project explores this new type of computing

*Note: Preference will be given to students with a knowledge of Computer Architecture, VHDL, Python, and FPGAs.*

**Professor Torsten Suel**
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**Research Projects:**
- **Efficient Index Updates for Web Search Engines**
  Search engines use very large index structures covering billions of documents. Updating such index structures can be a major performance bottleneck when the structures are located on disk. This project attempts to use smart algorithms and data structures to
increase the efficiency of such algorithms for the case when a new, only slightly modified, version of an already indexed document is added to the index.

• **Sharding Social Networks**
  Social network data may involve billions of nodes and edges, each containing a certain amount of text or other data. To achieve acceptable performance, such graphs need to be partitioned over a number of machines. This project will attempt to improve the state of the art in distributing social network graphs over machines, for a given access pattern.

• **SIMD- Algorithms for Top-k Search Query Processing with Large K**
  A lot of research has focused on top-k query processing, where the goal is to return the k highest-scoring results as quickly as possible. There are many algorithms that can do much better than a brute-force scan. However, the performance of these algorithms breaks down when k is larger than about 50, and for k of 1000 or more the brute-force approach can often win out. The goal here is to come up with algorithms that are much faster even for large k, and that achieve high speed by using the SIMD commands available in the current generation of Intel processors.

*Note: Preference will be given to students majoring in Computer Science or Computer Engineering with a minimum GPA of 3.5 and good knowledge of algorithm design and analysis, as well as strong coding skills preferably in C/C++ for projects #1 and #3.*

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**ELECTRICAL AND COMPUTER ENGINEERING**

**Professor Farshad Khorrami**  
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**Research Projects:**

- Robotics
- Autonomous Unmanned Systems

*Note: Preference given to junior or senior students with a 3.5 GPA and knowledge of C programming.*

**Professor Quanyan Zhu**  
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**Research Projects:**

- **IoT Project: Analyzing Security, Privacy and Trust in the Cloud-Based Internet of Things**  
The Internet of Things foresees a highly networked future, where every object is integrated to interact with each other, allowing for communications between objects, as well as between humans and objects, which enables the control of intelligent systems in our daily lives. As the boundary between humans and machines gets blurry, more focus is needed in order to provide security, privacy and trust solutions. Since IoT devices are not only monitoring, e.g., through sensors, but also controlling physical objects, e.g., though actuators, the impacts of security attacks can be devastating including serious safety impacts, as in the case of connected vehicles and smart Healthcare The project aims to explore the security, privacy, and trust vulnerabilities inherent in the infrastructure used to build the existing IoT applications.

- **Data Science Project 1: Load Balancing of Citi Bikes**  
Empty and full stations pose a major problem in the Citi bike system. After all, bike share really only needs two things to work: a bike to ride and a dock to leave the bike. Citi bike, like other bike share programs in the US, has a solution: use trucks to rebalance the stations, carrying bikes from full racks to empty ones. The issue is that the trucks do the rebalancing reactively -- waiting for a pile up before swooping in to save the day-- rather
than acting preventively. This project aims to develop smart and predictive analytics to more effectively meet the demand over the city.

- **Data Science Project 2: Optimizing the Quality and Delivery of City Emergency Medical Services**
  The City Fire Department conducts thousands of emergency medical responses each year, providing pre-hospital treatment and transportation to hospitals to reduce morbidity and mortality. In order to optimize these services, the city collects data on emergency medical services (EMS) deployment and incidents, and would like to build analytics that increase EMS efficiency, effectiveness, and long-term sustainability. To help the city meet these goals, the project aims to build a system that provides appropriate, targeted emergency medical call response. The project focuses on three areas: ensuring that medics are strategically placed for deployment, optimizing deployment of medics so that teams are not sent on too many or too few runs, and appropriately maximizing the limited number of EMS personnel and resources.

- **Security Game Project: Board Game Design and Game-Theoretic Analysis for Learning Cyber Attack and Defense**
  In this project, the students will design board games to mimic the cyber security defense. Students will use game-theoretic tools to simulate and analyze the outcome of the designed game. The game is designed to be pedagogical and entertaining for K-12 students to grasp the concepts of cyber security while playing the game. A desirable team consists of 2-3 students. Examples of games that are related to this project are (i) Protection Poker Game [http://collaboration.csc.ncsu.edu/laurie/Papers/ProtectionPoker.pdf](http://collaboration.csc.ncsu.edu/laurie/Papers/ProtectionPoker.pdf) and (ii) Code Monkey Island Game [http://mashable.com/2014/06/20/code-monkey-board-game/](http://mashable.com/2014/06/20/code-monkey-board-game/).

Note: Preference will be given to students with a minimum GPA of 3.7 and experience with computing software.

### MATHEMATICS

Professor Lindsey Van Wagenen  
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**Research Projects:**
- **Mathematics of Climate Change: Investigation of Mathematical Models in Current Research**
  Mathematical models are at the heart of climate change research. We will study some of the fundamental models, simulations and their domains of applicability with an emphasis on statistical analysis and conceptual model validation. Possible applications of the Mahalanobis-Taguchi System to these areas of climate change research will be considered.

- **Mathematics of Sustainability: Robust Decision Making & Methods for Environmental Research**
  We will build on previous applications of the Mahalanobis-Taguchi System (MTS) to environmental and sustainability issues with the aim of identifying criteria for robust decision making and developing an MTS-based metric to assess the strength of the predictions.

*Note: Preference will be given to students with experience in data analysis, differential equations, and programming.*
MECHANICAL ENGINEERING

Professor Weiqiang Chen
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Research Projects:

• Mechanical Phenotyping of Inflammatory Breast Cancer Stem Cells
  Inflammatory breast cancer (IBC) is the most aggressive and lethal form of breast cancer with up to one-third of patients having distant metastases at initial diagnosis. Evidence indicates that cancer cells with stem cell-like properties, termed ‘cancer stem cells’ (CSCs), play a major role in the aggressive nature of IBC. Specific targeting of CSCs could be the key to effectively treating IBC. However, current knowledge about aggressive IBC and its CSC component remains sparse. It is becoming increasingly clear that in vivo CSCs reside in a distinct microenvironment, the "CSC niche", where both biomechanical and biochemical environmental factors such as mechanical signals, adhesive and soluble factor gradients, contributes to the overall control of CSC phenotypes and activities. In response to the biomechanical signals in the CSC niche, CSCs display distinct adaptive biomechanical properties in order to facilitate functional behaviors such as self-renewal, epithelial–mesenchymal transition (EMT), and invasive and metastatic activities. Hence, it is important to develop an understanding of the biomechanical attributes of IBC CSCs, the so-called “mechanophenotype”, that underlie CSCs’ tendencies toward tumorigeneses and metastases. This would significantly advance the field, but has yet to be undertaken. Therefore, this research will address this critical knowledge gap by examining how distinct adaptive mechanophenotypes of IBC CSCs such as cell stiffness, actin cytoskeleton (CSK) structure, and force contribute to the CSCs’ tendencies toward tumorigeneses and metastases.

• Tunable and Multifunctional Vascularized Microenvironment for Inflammation-Angiogenesis Study
  As the essential parts of circulatory systems, vascular networks have appealed numerous attention in current clinical and translational researches. Engineering vascularized microenvironment models with tunable, multifunctional, and controllable capabilities are important for mimicking in vivo tissue conditions and buildup in vitro disease models. While current in vitro vascular models can make study simpler, the results can’t be used for solutions immediately, due to the over-simplifying of in vivo vascular systems, as well as the lack of controllability in vascularized three-dimensional microenvironment including biochemical (e.g. growth factors, cytokines), biophysical (e.g. flow stress, substrate stiffness), intercellular communications (e.g. immune cells, cancer cells) and cell–matrix interactions. Microfluidics provides one promising technique with the capability of controlling, tuning and multifunctioning, due to its inherent features of large-scale integration and controllable flow patterns in microscale. This research will develop a microfluidic three-dimensional vascularized microenvironment integrated with tunable extracellular matrix stiffness, cell-matrix interactions, and cell-cell interactions. Using such platform to mimic more-like in vivo conditions, inflammatory-induced angiogenesis will be specially investigated under different cell-matrix interactions, which imply the interdependent roles of biochemical and biophysical factors in regulating vascular reorganizations. This work can provide an integrated, tunable and multifunctional microfluidic platform for studying interactions of inflammation and angiogenesis in vascular-implicated disease models

• Plasmofluiddic Biosensor Microarray for Single-Cell Functional Immunophenotyping
  The immune system is crucial to protecting living organism from invasions of viruses, bacteria, and parasitic worms, and is capable of distinguishing healthy tissue from that which is diseased. An accurate and real-time measurement of different subsets of
immune cells’ functions is critical for obtaining insight into the immune status of a living organism, as well as evaluating the disease stage and drug efficacy. In particular, quantitative and dynamic analyses of the cytokine secretion profiles of individual immune cells are required for precise determination and characterization of the “immune phenotype” of patients. However, quantitative characterization of functional signature and diversity of immune cells from patient blood is currently challenging. This difficulty stems from not only the limitations of conventional methods, but also the intrinsic heterogeneity and complexity of the immune cell community. This proposed research expects to offer a new integrated plasmofluidic immunophenotyping platform: a plasmofluidic nanobiosensing system for efficient on-chip isolation, stimulation, and sensitive cellular characterization of single immune cells from human blood. This new plasmofluidic biosensing system will enable a highly sensitive, label-free, multiplex and sample-sparing cytokine detection at the single-cell level.

*Note: Preference will be given to students with a minimum GPA of 3.5.*

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**Research Projects:**

- **Product Security in Additive Manufacturing (3D Printing)**  
  Additive manufacturing, also known as 3D printing, has been adopted in many fields including automotive, aerospace, and medical. As a completely digital process chain from developing a CAD model to the final printing step, it is vulnerable to cyber-attacks. Due to the incidents of cybersecurity breaches around the world, protecting the hardware CAD models with embedded security features has become a priority. In this project, we will develop and implement a surface pattern on the product during the CAD stage, which will make a counterfeit product identifiable if it is not printed under the prescribed conditions. Basic knowledge of SolidWorks is required for this project. Familiarity with 3D printers is will be useful.

- **Development of Fiber-optic Loop Sensor for Chemical Detection**  
  Fiber optic loop sensor (FOLS), invented at Composite Materials and Mechanics Lab, provides advantages of simple construction and versatility in detecting transient changes in surrounding environment. FOLS has been demonstrated for use in detection of force, displacement, and vibration. The current research is being conducted to theoretically and experimentally demonstrate that FOLS can also be applied in petroleum industry for detection of hydrocarbon in petrochemicals. Simple and low cost chemical detection technologies are important for deep see oil wells for preventing blow outs and chemical spills.

- **Development of Lightweight Polymer Matric Composite Materials**  
  This research project focuses on manufacturing of lightweight polymer based composites and their use in 3D printing. Hollow microparticles are used as fillers in the polymer to create composite material that is converted to a filament used in 3D printers. The project includes studying the extrusion process, quality of the filament, and printing process using this new composite filament. Mechanical and thermal properties of this filament will also be studied to understand the optimum process conditions to print lightweight composite structures

Professor Joo Kim  
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Research Projects:

- **Robotic Gait and Manipulation: Modeling, Control, and Experiment**
  Activities will include programming, hands-on building and experiments, and/or data processing as related to the energetics and stability of a robotic arm and a biped robot.
- **Biomechanical Modeling and Testing of Human Kinematics and Dynamics**
  Activities will include programming, human subject experiments, and/or data processing as related to the energetics and stability of human walking.

*Note: Preference given to students with a minimum GPA of 3.4.*

Professor Sanghoon Nathan Lee
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**Research Project:**

- **Mechatronic-based Renewable Energy System**
  Create a prototype system, which generate power in renewable manner with aid of mechatronics.

*Note: Preference will be given to students who can program microcontrollers (BS2 or Arduino) and analyze electric circuits.*

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**Research Project:**

- **Experiments on Social Learning of Zebrafish**
  In social learning theory, the process of learning is a cognitive practice that is held in social contexts, whereby knowledge of the location of a food source or a predator may be transferred from informed to naïve individuals. However, the determinants and the nature of this transfer are not yet fully comprehended. In this project, inspired by Pavlovian conditioning, we will seek to study the performance of a naïve fish trained to avoid or approach a stimulus in a conditioned place preference test. Working under the supervision of senior laboratory members, the student will design and conduct experiments to understand zebrafish learned tasks. Experiments will investigate the behavior of shoals of naïve fish swimming with a trained fish, or a robotic fish following a pre-determined trajectory. Data will be used to compute salient measures of collective behavior and inform the calibration of a data-driven model that could explain social learning. The student will be trained in animal experiments, underwater robotics, state-of-the-art image processing tools, and information-theoretic tools for the quantification of social interactions among fish.

- **A New Experimental Approach to Study Fluidic-structure Interactions**
  Fluid-structure interactions are pervasive in biology, physics, and engineering. However, accurate experimental methods to perform simultaneous measurement of flow physics and structural deformations are currently lacking. In this project, we will seek to explore the integration of state-of-the-art methods in experimental fluid dynamics, experimental solid mechanics, and smart structures to establish a novel approach for the analysis of...
fluid-structure interactions. Working under the supervision of senior laboratory members, the student will perform experiments, material fabrication, and data analysis on dynamic instabilities. The student will be trained in image analysis techniques, used for measuring the fluid flow and the structural deformation, and in the synthesis of mechanochromic materials.

- **Measurements in Fluids Using Optically Active Materials**
  Active materials are continuously being integrated in the design of scientific instruments to advance our understanding of the physics of solids and liquids. The goal of this project is to advance the field of experimental fluid mechanics through the development of new optically active materials, which will change their coloration as a function of their mechanical deformation. The student will collaborate with a graduate researcher to fabricate and test a sensing microsystem based on such active materials. During the project, the student will be trained in experimental fluid mechanics and material science to develop a scientific understanding of the novel microsystem.

**TECHNOLOGY, CULTURE AND SOCIETY**

Professor Jonathan Bain
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**Research Project:**

- **Non-locality in Intrinsic Topologically Ordered Systems**
  (This is a research project in the field of conceptual foundations of physics.) Recent theoretical work in condensed matter physics has sought to define the notion of "intrinsic topological order" (ITO). ITO systems are characterized by two types of non-locality. The first type is associated with non-local topological properties, including degenerate ground states with the degeneracy depending on the topology of the system’s state space, and low-energy excitations that obey fractional "anyonic" statistics. ITO systems are also characterized by a second type of non-locality associated with a particular type of quantum entanglement, referred to as "long-range entanglement". Recent work in quantum information theory has sought to exploit these two types of non-locality in ITO systems as a way to "topologically protect" the information encoded in entangled qubits from decoherence due to local errors. Central to this work is the view that topological non-locality can be exploited to protect the non-locality associated with quantum entanglement. In this project, we will consider the extent to which topological non-locality is different from quantum entanglement non-locality, and whether, as some authors have suggested, the topological non-locality of an ITO system entails its quantum entangled non-locality.

*Note: Preference given to students with some exposure to college-level physics and math, an interest in condensed matter physics, and an interest in conceptual and foundational issues in physics.*

Professor Christopher Leslie
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**Research Projects:**

- **Digital Humanities**
  This project involves the use of location-aware apps to improve access to the humanities. There is a history version related to the Tandon School of Engineering’s past locations in downtown Brooklyn and there is a literature project relating to the life and work of the American poet Gertrude Stein.
Note: Preference will be given to students with good written communication skills and experience with coding, HTML, PHP, MySQL, and Layar.

TECHNOLOGY MANAGEMENT AND INNOVATION

Professor Oded Nov
onov@nyu.edu

Research Projects:
• Human Computer Interaction and Personal Genomics Exploration
• Human Computer Interaction for Decision Making and Consumer Finance

Note: Preference will be given to students with a minimum GPA of 3.3 and programming experience, front end back end.