Fall 2021 Undergraduate Research Projects

Project Name:	Thermal management of electronic devices	**Project ID:**	R001
Supervisor:	Justin A Weibel	**Number of Positions**	Multiple
Project Description:	The continued miniaturization of electronic devices, with expanded functionality at reduced cost, challenges the viability of products across a broad spectrum of industry applications. Proper thermal management of electronic devices is critical to avoid overheating failures and ensure energy efficient operation, from supercomputers to electric vehicles. Research projects in the Cooling Technologies Research Center (CTRC) are exploring new technologies and discovering ways to more effectively apply existing technologies to addresses the needs of companies and organizations in the area of high-performance heat removal from compact spaces. One of the distinctive features of working in this Center is training in practical applications relevant to industry. All of the projects involve close industrial support and collaboration in the research, often with direct transfer of the technologies to the participating industry members.		
Final Deliverables:			
Weekly Working Hours	Flexible, and to be decided based on discussion with the supervisor.		
For Credits/Pay	Flexible, and to be decided based on discussion with the supervisor.		
Desired Qualifications	Projects in the Center involve both experimental and computational aspects, are multi-disciplinary in nature, and are open to excellent students with various engineering and science backgrounds. Multiple different research project opportunities are available based on student interests and preferences.		

Project Name:	Purdue Overclocking (OC) Team	**Project ID:**	R002
Supervisor:	Justin A Weibel	**Number of Positions**	Multiple
Project Description:	Computer overclocking takes advantage of thermal headroom in component designs to improve performance at the cost of increased power consumption and heat productions. Sponsored by the Institute of Electrical and Electronics Engineers Electronics Packaging Society (IEEE EPS), and hosted by the Cooling Technologies Research Center (CRTC), the misson of the Purdue Overclocking (OC) Team is to push existing computer hardware to its limit with novel cooling solutions. Each year, the Purdue OC team aims to develop a new cooling system (e.g., liquid nitrogen cooling) to compete in IEEE's overclocking championship held at the IEEE ITherm conference.		
Final Deliverables:	Deliverables include competing in both physical and virtual overclocking competitions, reporting performance benchmarks, and presenting design reviews of novel cooling solutions.		
Weekly Working Hours	Flexible, and to be decided based on discussion with the supervisor and other team members.		
For Credits/Pay	Voluntary		
Desired Qualifications	Open to any interested students.		

Project Name:	Application of Machine Learning Algorithms to the Structural Analysis of aerospace systems	**Project ID:**	R003
Supervisor:	Prof. Fabio Semperlotti	**Number of Positions**	3
Project Description:	In recent years, machine learning and artificial intelligence algorithms have been rapidly expanding to the computational mechanics world. They offer the possibility to perform very challenging computations that would otherwise be beyond reach for more classical methods based on the numerical solution of differential equations. The project will involve the development and numerical implementation of machine learning algorithms to simulate the response of structural and multiphysics systems in the static and dynamic regimes. You will acquire the following knowledge: basic knowledge of neural network architectures; basic skills for the simulation of neural networks (writing and executing simple codes); basic theoretical and numerical skills for the static and dynamic analysis of structural systems.		
Final Deliverables:	Final report summarizing the models developed and the numerical results obtained. Original results of sufficient impact will be expanded in a technical publications (either conference or journal).		
Weekly Working Hours	Approximately 12 hrs per week		
For Credits/Pay	For credits: 3		
Desired Qualifications	Juniors and seniors. Interest in solid mechanics and dynamics. Helpful skills: Matlab, Python, Finite Elements.		

Project Name:	Design, simulations, and experimental validation of elastic metamaterials for the control of structural vibrations.	**Project ID:**	R004
Supervisor:	Prof. Fabio Semperlotti	**Number of Positions**	3
Project Description:	Elastic metamaterials are a class of composite materials that can achieve very unconventional mechanical and dynamic properties including, as an example, negative Poisson's ratios and cloaking. The project will involve the design and numerical simulation of composite metamaterials to achieve efficient passive control of structural vibrations. The successfully identified material systems will be built by additive manufacturing and tested in the laboratory. You will acquire the following knowledge: basic understanding of the theory of periodic composite materials; basic skills in numerical dynamic simulations of materials and structures; basic laboratory skills to prepare test samples and to test the dynamic response of materials (laser vibrometry, digital image correlation, shaker and piezoelectric transducers).		
Final Deliverables:	Final report summarizing the models developed and the numerical results obtained. Original results of sufficient impact will be expanded in a technical publications (either conference or journal).		
Weekly Working Hours	Approximately 12 hrs per week		
For Credits/Pay	For credits: 3		
Desired Qualifications	Juniors and seniors. Interest in solid mechanics and dynamics. Helpful skills: Matlab, Finite Elements.		

Project Name:	Development of structural health monitoring techniques for nanoengineered materials.	**Project ID:**	R005
Supervisor:	Prof. Fabio Semperlotti	**Number of Positions**	2
Project Description:	Structural health monitoring is a field of mechanics dedicated to the development of real-time inspection techniques to identify the possible development of structural damage in in-service structures. Self-sensing materials, such as nanoenegineered composites, allow tracking and detecting damage by monitoring their electrical response. The project will involve the development of remote sensing techniques to monitor the status (that is the possible development of cracks and structural damage) in nanoengineered composites. You will acquire the following knowledge: basic understanding of nanoengineered composites and structural health monitoring; basic skills in machine learning to develop sensing techniques; basic laboratory skills to fabricate nanoengineered composites and test them via electrical probing.		
Final Deliverables:	Final report summarizing the models developed and the numerical results obtained. Original results of sufficient impact will be expanded in a technical publications (either conference or journal).		
Weekly Working Hours	Approximately 12 hrs per week		
For Credits/Pay	For credits: 3		
Desired Qualifications	Juniors and seniors. Interest in solid mechanics and dynamics. Helpful skills: Matlab, Finite Elements.		

Project Name:	Additive manufacturing of energetic materials	**Project ID:**	R006
Supervisor:	Yung C Shin	**Number of Positions**	1
Project Description:	This study is to explore the additive manufacturing of energetic materials (soft material) using a new 3D printer available in the supervisor's lab. The student is expected to optimize the process parameters to build successful samples using various specified materials and work with a graduate student to study its resultant properties. The participating undergraduate student(s) is expected to work on optimizing the process parameters, preparation of specimens and post characterization and testing with a graduate student(s).		
Final Deliverables:	It is expected to submit weekly or bi-weekly reports describing the findings and results of the research project during the regularly scheduled meetings. A final written report is required for the final grade, which contains all the experimental results, collected testing results and analysis results.		
Weekly Working Hours	10		
For Credits/Pay	For credits: 3 For Pay: (Hourly rate) NA Voluntary		
Desired Qualifications	Sophomore or higher standing with the minimum GPA of 3.4		

Project Name:	Laser transmission welding of glasses on metals	**Project ID:**	R007
Supervisor:	Yung C Shin	**Number of Positions**	1
Project Description:	The research is to experimentally investigate the feasibility of joining fused silica on polymers and metals using the laser transmission welding. Welding of dissimilar materials have many applications. To this end the student will carry out the following tasks: 1. Literature review of related field 2. Design experiments and carry out a systematic parametric study on the relationship between process parameters and welding quality using the available laser micro-welding system. 3. Characterize the resultant microchannel quality using various optical measurement techniques such as optical microscope and optical surface profiler. 4. Optimize the process parameters to achieve the best quality and throughput. 5. Generate a technical report summarizing all the findings. • The student will learn how to schedule and prioritize his/her work according to the overall goals and tasks. He will have a weekly meeting with me to discuss the progress and future directions. • The student will gain knowledge and skills about lasers, the operation of the laser, and the characterization methods. • The student will gain essential knowledge about how to do research or solving an open-ended problem using creative thinking.		
Final Deliverables:	It is expected to submit weekly or bi-weekly reports describing the findings and results of the research project during the regularly scheduled meeting. A final written report is required for the final grade, which contains all the experimental results, collected microstructure data and analysis results.		
Weekly Working Hours	10		
For Credits/Pay	For credits: 3 For Pay: (Hourly rate) NA Voluntary		
Desired Qualifications	Sophomore or higher standing with a minimum GPA of 3.4		

Project Name:	Data-driven modeling of microstructure-properties relationships for additively manufactured metal parts	**Project ID:**	R008
Supervisor:	Yung C Shin	**Number of Positions**	3
Project Description:	This study is to investigate the mechanical properties of metal alloy parts built by various additive manufacturing (AM) processes in terms of the resultant microstructure and to establish a data-driven model between the microstructure		

	and mechanical properties. Additive manufacturing is gaining global popularity due to its unprecedented capabilities in shaping complex shapes. However, one of the challenges remaining for widespread industrial use of AM is to predict/control the resultant mechanical properties. Additive manufacturing due to its inherent nature of localized heating and cooling produces heterogeneous microstructure, which affects resultant mechanical properties. Due to the number of parameters used in AM, predicting the resultant mechanical properties is very time-consuming and expensive, which remains one of the main obstacles for wide adoption in the industry. This study is to establish property-structure relationships of AM-built metal parts, which will alleviate this problem. The participating student(s) is expected to work on printing tensile and compression specimens by various metal additive manufacturing, prepare them for microstructure measurement, conduct heat treatment, if necessary, and perform mechanical testing using a universal testing machine available in the supervisor's lab. Finally, it is expected to establish microstructure-mechanical property relationships using a machine learning technique such as multilayer neural networks and deep learning methods.
Final Deliverables:	It is expected to submit weekly reports describing the progress, findings and results of the research project during the regularly scheduled meetings. A final written report is required for the final grade, which shall contain a literature review, collected microstructure data, all the experimental results, and analysis results.
Weekly Working Hours	10
For Credits/Pay	For credits: 3 For Pay: (Hourly rate) N/A Voluntary
Desired Qualifications	Junior or higher standing with the minimum GPA of 3.5

Project Name:	***Li-ion Battery Analytics***	**Project ID:**	R009
Supervisor:	Partha P. Mukherjee	**Number of Positions**	3
Project Description:	Lithium ion (Li-ion) batteries are ubiquitous. Thermal characteristics of these systems are critical toward safer and high-performance batteries for electric vehicles. As part of this research, thermal analysis of heat generation rates under normal and anomalous operating conditions of Li-ion cells will be performed.		
Final Deliverables:	The student will work closely with a senior graduate student researcher on the phsyics based modeling, machine learning based analysis in the form of weekly reports. The final deliverable will be one end-of-summer research report (based on the weekly progress) and a presentation at the research group meeting.		
Weekly Working Hours	10		
For Credits/pay	For credits: 3 credits		
Desired Qualifications	Rising senior or Junior (with good analytical thinking and skills with Matlab or similar analysis tools)		

Project Name:	Radiative cooling paints for energy-free air conditioning	**Project ID:**	R010
Supervisor:	Xiulin Ruan, Andrea Felicelli, Yun Zhang	**Number of Positions**	2
Project Description:	Raditive cooling is a passive cooling technology by reflecting the sunlight and emitting heat to the deep space. It has the promise to provide free air conditionging to buidlings and other infrastructures, cutting the carbon emissions. Moreover, it sends off heat to deep space instead of keeping it in the city and on the earth, therefore mitigates the heat island effect and cools down the earth. Learn more about our recent work covered by CNN, Purdue News, and many other news media (Google search "cooling paint Xiulin Ruan"). In this project the undergraduate students will assist PhD student Andrea Felecelli and postdoctoral fellow Dr. Yun Zhang to design, fabricate, and measure nanoparticle-polymer composites for high-performance radiative cooling. The nanoparticles will be mixed with polymers to form nanofluids, which are then cured into thin films with various thicknesses. The optical properties will be characterized with UV-VIS-NIR and FTIR spectrometers. Field tests will be performed to assess the temperature they can cool below the ambient temperature and the net cooling power of these nanocomposites. Modeling and simulations may also be a component of the work to guide the design of the nanocomposites.		
Final Deliverables:	Literature and information search, modeling results, synthesized nanocomposites samples, measurement data, final presentation.		
Weekly Working Hours	7-10 hours		
For Credits/Pay	For credits: (# of credits): 2-3 Vontuntary		
Desired Qualifications	Junior or senior standing		

Project Name:	Nanoscale 3D printing	**Project ID:**	R011
Supervisor:	Xianfan Xu	**Number of Positions**	Up to 2
Project Description:	The ability to create 3D structures in the micro and nanoscale is important for many applications including electronics, microfluidics, and tissue engineering. This project deals with development and testing of a setup for building 3D structures using a femtosecond pulsed laser. A method known as two photon polymerization is used to fabricate such structures in which a polymer is exposed to laser and at the point of the exposure the polymer changes its structure. Moving the laser in a predefined path results in the desired shape and the structures. The setup incorporates the steps fromdesigning a CAD model file to slicing the model in layers to generating the motion path of the laser needed for fabricating the structure. Possible improvements to the process by the undergraduate researcher include control algorithms, better CAD models, and better manufacturing strategies.		
Final Deliverables:	Summary Report		
Weekly Working Hours	10		
For Credits/Pay	For credits: (# of credits) 3 For Pay: (Hourly rate) Vontuntary		
Desired Qualifications	Mechanical Engineering Junior or Seniro standing with GPA > 3.5, CAD models		

Project Name:	Nanoscale Heat Transfer	**Project ID:**	R012
Supervisor:	Xianfan Xu	**Number of Positions**	Up to 2
Project Description:	This project deals with study of heat transfer in very thin film materials (as thin as a few atomic layers) using advanced measurement techniques including Raman spectroscopy and ultrafast laser spectroscopy. Heat transfer in nanoscale materials shows superior characteristics for applications in numerous advanced electronic, photonics, and energy conversion devices. Their thermal transport behaviors are also different compared with bulk materials, and an understanding of the transport process is important for applications of these materials. We use non-contact, optical method (i.e., lasers etc.) to investigate heat flow in these materials. The undergraduate student will work with graduate students to learn to use state-of-the-art experimental facilities, carry out experiments, and analyze experimental results.		
Final Deliverables:	Summary Report		
Weekly Working Hours	10		
For Credits/Pay	For credits: (# of credits) 3 For Pay: (Hourly rate) Vontuntary		
Desired Qualifications	Mechanical Engineering Junior or Seniro standing with GPA > 3.5, CAD models		

Project Name:	3D Printing and Characterization of a Pharmaceutical Tablet	**Project ID:**	R013
Supervisor:	Carl Wassgren	**Number of Positions**	1
Project Description:	The objective of this project is to 3D print pharmaceutical tablets and characterize the tablet properties. The student working on this project will need to complete the following tasks: (1) Complete laboratory safety training. (2) Set up, troubleshoot, and test a 3D printer for operation. (3) 3D print tablets using pharmaceutical powder formulations and different manufacturing conditions. (4) Complete training on laboratory characterization equipment. (5) Measure tablet characteristics, including the tablet density, friability, dissolution time, and internal microstructure using x-ray micro computed tomography. (6) Participate in weekly research group meetings. (7) Help prepare a written report describing the project effort. The student will work closely with the Lab Manager, Dr. Clairmont Clementson, and Prof. Carl Wassgren.		
Final Deliverables:	The project deliverables include a written report describing the project effort. The student will also be expected to participate in weekly research group meetings where they'll provide short updates (~5 – 10 minutes) on their work.		
Weekly Working Hours	12 hrs/wk		
For Credits/Pay	For credits: 3 (# of credits)		
Desired Qualifications	The student working on this project should be comfortable working in a laboratory setting and have good communication skills. There is no requirement on having familiarity with laboratory characterization equipment as this training will be provided. The 3D printer used in this work is new to the laboratory so the initial effort will be spent on bringing this printer online.		

Project Name:	Microelectronics device reliability characterization	**Project ID:**	R014
Supervisor:	Ryan Wagner	**Number of Positions**	1-3
Project Description:	The shrinking size of microelectronic devices has led to greatly increased performance but at the cost of increased complexity of failure events. Physics-of-failure modeling and traditional reliability approaches both attempt to build models that describe the reliability of a device and predict the meantime to failure. However, reliability predictions are inherently limited by the availability and quality of failure data. An atomic force microscope (AFM) consists of a cantilever mounted, nanometer-scale tip interacting with a surface. In AFM, nanoscale imaging is obtained by scanning the tip over the surface. If an electrical potential is applied to the tip, the electrical properties of the surface can be probed. This project will investigate different electrical characterization methods using AFM for the characterization of microelectronic device performance and failure. Specifically, this includes looking at the effect of humidity on different AFM electrical characterization modes, performing accelerated lifetime testing of devices during AFM imaging, and testing novel methods of characterizing piezoelectric material response with AFM.		
Final Deliverables:	Report or paper summarizing final project results		
Weekly Working Hours	9 to 12 hours		
For Credits/Pay	For credits: 3		
Desired Qualifications	Junior or senior standing, GPA greater than or equal to 3.0.		

Project Name:	Multiscale mechanical analysis of polymer blends and composites	**Project ID:**	R015
Supervisor:	Ryan Wagner	**Number of Positions**	1-3
Project Description:	Bulk properties of polymer systems are driven by a combination of molecular-scale chemical properties, microstructure, and defects. Manufacturers are constantly tweaking chemical formulation and manufacturing processes to optimize materials for specific applications. To support this, tools for characterizing mechanical properties across multiple length scales are needed. Dynamic mechanical analysis (DMA), instrumented indentation testing (IIT), and atomic force microscopy (AFM) can characterize mechanical properties across the macroscale, microscale, and nanoscale, respectively. This project will focus on testing, improving, and comparing different methods of mechanical characterization for polymer systems. Specifically, this will include the development of a new method of loss tangent analysis for AFM, development of reference samples and their characterization with DMA, IIT, and AFM, and mechanical analysis of different polymer systems of interest to our research group. Target applications for this work include advanced electronics packaging materials and hermetic bag technologies for crop storage.		
Final Deliverables:	Report and/or scientific paper detailing the results.		
Weekly Working Hours	9 to 12 hours		
For Credits/Pay	For credits: 3		
Desired Qualifications	Junior or senior standing, GPA greater than or equal to 3.0.		

Project Name:	3D imaging system development	**Project ID:**	R016
Supervisor:	Song Zhang	**Number of Positions**	Up to 3
Project Description:	This project aims at developing a 3D imaging device that can be used by law enforcement for crime scene evidence collections. The student will closely work with a graduate student to help both software and hardware system development.		
Final Deliverables:	• Software algorithms and result report • Hardware design and relevant documentations		
Weekly Working Hours	10 hours/week		
For Credits/Pay	Based on discussion with supervisor.		
Desired Qualifications	Basic C or C++ programming, strong communication skills		

Project Name:	Soft Haptic Actuator Display	**Project ID:**	R017
Supervisor:	Professor Laura Blumenschein	**Number of Positions**	1 to 2
Project Description:	Construction and testing of a display to render haptic (sense of touch) forces to a human as they interact with the display. This project will involve working with soft, pneumatic actuators and mechatronic control systems. Displays will be designed to allow for communication of robot intent during human robot interaction.		
Final Deliverables:	Soft pneumatic display design		
Weekly Working Hours	10 hours per week		
For Credits/Pay	For credits: (3)		
Desired Qualifications	Some previous experience with electronics and Arduino or similar systems		

Project Name:	Understanding Growing in Soft Robots	**Project ID:**	R018
Supervisor:	Professor Laura Blumenschein	**Number of Positions**	1
Project Description:	Testing how material and environmental properties affect the ability of soft growing robots (vinerobots.org) to move by growing. Will be continuing a previous project with a experimental setup, so project will primarily consist of data collection and analysis.		
Final Deliverables:	Data set for growth based on material composition		
Weekly Working Hours	10 hours per week		
For Credits/Pay	For credits: (3)		
Desired Qualifications	Matrix algebra and MatLab proficiency		

Project Name:	Immersible sensors	**Project ID:**	R019
Supervisor:	Euiwon Bae	**Number of Positions**	2
Project Description:	Applied optics lab is searching for UG student who are interested in continused development of immersible photonic sensors. Project is related to umbrella project from USDA pathogen detection and we are seeking student who will do the following. -Mechanical : design a water tight ensloure that could be repeatily opened up and closed again without loosing the water proof nature. -Electrical : design a arduio based light detection system. Requirement is to be operated by coin/lithium battery so that min of 10 hrs of operation is guaranteed.		
Final Deliverables:	Ensloure protoypte (Mechanical) and sensor prototype (Electrical)		

Weekly Working Hours	5-10 hrs
For Credits/Pay	For credits: (# of credits) 2 credits (5 hrs/week) or 3 credits (9 hrs/week) For Pay: (Hourly rate) Vontuntary
Desired Qualifications	

Project Name:	ML-based colony counting	**Project ID:**	R020
Supervisor:	Euiwon Bae	**Number of Positions**	2
Project Description:	Applied optics lab is searching for UG student who are interested in continued development of matlab-based machine learning algorithm for bacterial colony detection. Studnets will first analyze the target images (bacterial colonies) and extract the characteristic features using other programs (such as ImageJ). Once distinctive features are settled, students will code them in Matlab so that batch image processing will be implementd.		
Final Deliverables:	Working matlab scripts		
Weekly Working Hours	5-10 hrs		
For Credits/Pay	For credits: (# of credits) 2 credits (5 hrs/week) or 3 credits (9 hrs/week) For Pay: (Hourly rate) Vontuntary		
Desired Qualifications			

Project Name:	Research in laser-based manufacturing and materials processing	**Project ID:**	R021
Supervisor:	Prof. Benxin Wu	**Number of Positions**	~2
Project Description:	Students are expected to perform work in the field of laser-based manufacturing and materials processing. A student may be involved in one or multiple topics in laser-based additive and/or substractive manufacturing.		
Final Deliverables:	Students will be evalualted based on the quantiy, quality and difficulty of the work performed. The exact form of deliverables depends on the actual topic(s) in which the student is involved.		
Weekly Working Hours	Flexible and up to discussion.		
For Credits/Pay	For credits: (# of credits) For Pay: (Hourly rate) Vontuntary		
Desired Qualifications	Good hands-on, material chateracterization and/or machine shop capabilities, etc.		

Project Name:	Micro- and Nano-Precision Characterization of Electronic Materials	**Project ID:**	R022
Supervisor:	Ganesh Subbarayan	**Number of Positions**	1-2
Project Description:	The goal of the project is to characterize the thermo-mechanical behavior of materials used in semiconductor device assemblies using custom-built sophisticated micro- and nano-precision mechanical testers. The tests will be on a variety of nonlinearly behaving materials at both room temperature and at elevated temperature.		
Final Deliverables:			
Weekly Working Hours	Variable – on average 5-10 hours/week		
For Credits/Pay	For credits: (# of credits) if desired For Pay: (Hourly rate) $10 Vontuntary		
Desired Qualifications	Junior or senior		

Project Name:	Course grained modeling of proteins	**Project ID:**	R023
Supervisor:	Arezoo Ardekani	**Number of Positions**	2
Project Description:	Therapeutic proteins are commonly employed in the treatment of various human diseases such as cancer, autoimmune and infectious diseases. The goal of this project is to model a protein using a structurally consistent coarse-grained model taking into account the spatially varying hydrophobic nature of the protein molecule. For realizing time and length scales relevant to protein dynamics, we will employ the numerical scheme of dissipative particle dynamics to represent the system force field using an open source code. We capture the time evolution of the protein microstructure in different scenarios. We will quantify the aggregation propensity of the protein. This study shows that numerical simulations can be an important tool for understanding the molecular mechanisms driving protein aggregation and efficiently designing molecular structures of proteins.		
Final Deliverables:	Working computational code modeling three different protein types		
Desired Qualifications	Junior		

Project Name:	Quantification of viral particles for continuous processing	**Project ID:**	R024
Supervisor:	Arezoo Ardekani	**Number of Positions**	2
Project Description:	The increasing worldwide demand for vaccines along with the intensifying economic pressure on health care systems underlines the need for further improvement of vaccine manufacturing. In addition, regulatory authorities are encouraging investment in the continuous manufacturing processes to ensure robust production, avoid shortages, and ultimately lower the cost of medications for patients. The limitations of in-line process analytical tools are a serious drawback of the efforts taken in place. In line analysis of viral particles are very limited, due to the large time required for the current techniques for detection, qualitative and quantitative analysis. Therefore, there is a need for new alternatives for viral detection.		
Final Deliverables:	Working model of the device or fabrication of the device		
Desired Qualifications	Junior		

Project Name:	Efficient and sustainable water technology	**Project ID:**	R025
Supervisor:	David Warsinger	**Number of Positions**	>2
Project Description:	Water and energy are tightly linked resources that must both become renewable for a successful future. However, today, water and energy resources are often in conflict with one another, especially related to impacts on electric grids. Further, advances in material science and artificial intelligence allow for new avenues to improve the widespread implementation of desalination and water purification technology. This project aims to explore nanofabricated membrane, artificial intelligence control algorithms, and thermodynamically optimized system designs. The students will be responsible for fabricating membranes, building hydraulic systems, analyzing data, modeling thermal fluid phenomenon, implementing control strategies in novel system configurations, academic and patent writing, and/or publication-quality graphics. More info on lab projects at: www.warsinger.com		
Final Deliverables:	All students will be required to read relevant, peer-reviewed literature and keep a notebook or log of weekly research progress. At the end of the semester or term, each student will present a talk or poster on their results.		
Weekly Working Hours	>10		
For Credits/Pay	For credit: 3 credits is typical For Pay: (Hourly rate) Vontuntary		
Desired Qualifications	Applicants should have an interest in several of these areas: thermodynamics, heat transfer, materials, water treatment, energy, and sustainability. Applicants with experience in some (not all) of the following are preferred: experimental design and prototyping, Python, LabView, EES, MATLAB, 3D CAD Software, & Adobe Illustrator. 2nd semester Sophomores, Juniors, and 1st semester Seniors are preferred. Strong preference for students staying for multiple semesters and/or summers		

PURDUE UNIVERSITY | Mechanical Engineering

Project Name:	Hopper Stress Measurements	**Project ID:**	R026
Supervisor:	Carl Wassgren	**Number of Positions**	1
Project Description:	Hoppers are common storage devices used in all industries that handle particulate materials. Improper design of a hopper can lead to a number of flow problems, including stagnant regions during discharge and flow stoppages due to material bridging within the hopper. Recently, finite element method (FEM) simulations have been developed to model the storage and flow of material within hoppers. In order to validate the FEM model predictions, experimental measurements of wall stresses within a hopper are desired. The objective of this project is to measure the wall stresses in an instrumented hopper for different loading and discharging scenarios.		
Final Deliverables:	• Wall stress measurements for two loading methods and a discharging hopper. Three repeats per testing condition are needed. • A Standard Operating Procedure document (2-5 pages) describing the experimental procedures used to make the measurements.		
Weekly Working Hours	~9 hr/wk		
For Credits/Pay	For credits: 3		
Desired Qualifications	• Junior or senior standing. • Ability to work independently. • This is an experimental project so the applicant should be interested in hands-on work.		

Mechanical Engineering Building ■ 585 Purdue Mall ■ West Lafayette, IN 47907-2088 ■ (765) 494-6900 ■ Fax: (765) 494-0539