PURDUE UNIVERSITY | Mechanical Engineering

Project-based research

Project Name:	Energy Storage Analytics	**Project ID:**	R001
Supervisor:	Partha P. Mukherjee	**Number of Positions**	3
Project Description:	Lithium ion (Li-ion) batteries are ubiquitous. Thermal safety and degradation characteristics of these systems are critical toward safer and high-performance batteries for electric vehicles. As part of this research, data-driven analytics of experimental and simulated performance under normal and anomalous operating conditions of Li-ion cells will be performed.		
Final Deliverables:	The final deliverable will be one end-of-semester research report (based on weekly progress presentations and updates) and one final presentation.		
Weekly Working Hours	Average: 8-10 hours		
For Credits/Pay	For credits: (# of credits) 3		
Desired Qualifications	Strong analytical skill and desire to learn new experimental and modeling/analysis tools.		

PURDUE UNIVERSITY | Mechanical Engineering

Project-based research

Project Name:	StickerSpec Sensing with SmartPhones	**Project ID:**	R002
Supervisor:	Thomas Beechem	**Number of Positions**	3
Project Description:	**Who we are**… Specere is a latin word that means "to look or behold." That's what we do. We look, explore, and examine different ways to: (1) move energy with light and (2) getinformation from light. More specifically, we are a light lab employing infrared physics to create spectroscopic, thermal, and sensing solutions. **Research Topic, StickerSpec Sensing:** We seek to make "cling stickers" like those you have hanging on your window to transfom a typical smartphone into a spectrometer equal in capability to the suitcase sized tools we have in our lab. *Success here will make colorimetric sensing ubiquitous to the masses allowing for: better health diagnostics in low-resource areas, consumer based quantifications of pollutants (lead in water/paint), and drone based probing of crop health and pollution.* ***What' You'll Do:*** Team members will be responsible for: (1) quantifying how smartphones measure color and (2) characterizing how filters affect these color measurements. Direct mentoring from Dr. Beechem will build your skills up in each area such that you will gain proficiency in spectroscopic tools and color theory. In addition, you will have the chance to participate in writing journal articles and pursuing patents based on your work.		
Final Deliverables:	Group Presentation outlining technical progress with accompanying "meeting slide" deck outlining research progress through term.		
Weekly Working Hours	15		
For Credits/Pay	For credits: (# of credits) 3		
Desired Qualifications	**Who we are seeking…** We look for motivated and hard-working undergraduates having both strong aspirations for post-graduate studies as well as those that are just "grad school curious." All applicants should be capable of working independently while effectively communicating within a team setting.		

PURDUE UNIVERSITY | Mechanical Engineering

Project-based research

Project Name:	Nanotechnology	**Project ID:**	R003
Supervisor:	Jong Hyun Choi	**Number of Positions**	2
Project Description:	The research has two themes: (1) DNA nanotechnology and (2) 2D materials. (1) The DNA nanotechnology project aims to develop mechanical systems at the nanoscale made of DNA and study their mechanics. (2) In the 2D materials project, we develop advanced materials for optoelectronics and energy storage devices.		
Final Deliverables:	Final presentation and monthly reports		
Weekly Working Hours	10 hours per week		
For Credits/Pay	For credits: (# of credits): 3 credits For Pay: (Hourly rate) Vontuntary		
Desired Qualifications	Curious, responsible, hard-working students		

PURDUE UNIVERSITY | Mechanical Engineering

Project-based research

Project Name:	Nanoscale 3D printing	**Project ID:**	R004
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 Or For Pay: (Hourly rate) $15 Or Vontuntary		
Desired Qualifications	Mechanical Engineering Junior or Senior standing with GPA > 3.5, CAD models, knowing Python is a plus		

PURDUE UNIVERSITY | Mechanical Engineering

Project-based research

Project Name:	Nanoscale Heat Transfer	**Project ID:**	R005
Supervisor:	Xianfan Xu	**Number of Positions**	Up to 2
Project Description:	This project deals with study of heat transfer in very thin film materials using Raman Spectroscopy and Ultrafast laser systems. Heat transfer in nanoscale materials including 2D materials (very thin layered materials bonded by van der Waal's force) shows superior characteristics for applications in numerous advanced 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 Or For Pay: (Hourly rate) $15 Or Vontuntary		
Desired Qualifications	Mechanical Engineering Junior or Senior standing with GPA > 3.5, having taken ME315 is a plus		

PURDUE UNIVERSITY | Mechanical Engineering

Project-based research

Project Name:	Soft Growing Robot for Inflatable Displays	**Project ID:**	R006
Supervisor:	Laura Blumenschein	**Number of Positions**	1
Project Description:	Projects involves the design, prototyping, and testing of pneumatically actuated soft growing robots/pins for the creation of inflatable displays. These displays will be composed of an array of individually actuated soft growing pins. The long-term goal of this project is the creation of a compliant soft haptic display capable of rendering haptic signals on a large scale for human-machine interaction. The student will fabricate initial prototypes using heat sealing techniques on Low-Density Polyethylene (LDPE) plastic tube to create soft pin arrays, similar to how vine robots (soft continuum robots that rely on growth for movement) are fabricated (see https://www.vinerobots.org/ for more details on vine robots). The student will also work in the mechanical/mechatronic design of a reel storage system (similar to a measuring tape) that will work as the storage/control unit for the growing pins. See Prof. Blumenschein's lab website for more information: https://lhblumen.wixsite.com/website-1		
Final Deliverables:	Prototype of actuation mechanism 10-minute presentation		
Weekly Working Hours	10		
For Credits/Pay	Credits		
Desired Qualifications	Familiarity with Arduino Familiarity with MATLAB Basic machine shop experience for prototyping CAD design Interest in design-oriented projects		

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Project Name:	Design and Characterization of Thin-filmed Pneumatic Artificial Muscle	**Project ID:**	R007
Supervisor:	Laura H Blumenschein	**Number of Positions**	1
Project Description:	Artificial muscles are a class of actuators that produce an contraction once powered, much like muscles found in biological systems. In the proposed project, we are interested in a design of artificial muscle that is constructed from thin membrane and powered by air pressure. The goal of the project is to develop an actuator with programmable behavior, i.e., the motion of the actuator by extension, contraction and bending can be designed by tuning some geometric parameters. The investigation involves identifying relevant design parameters, developing fabrication techniques, prototyping, and measuring the trajectory and force of the actuator, which contributes to developing an algorithm that generates actuator design and required pressure input from a given trajectory.		
Final Deliverables:	Drawing or textual description describing actuator design and its manufacturing process; position/force-strain data obtained from prototypes		
Weekly Working Hours	10		
For Credits/Pay	Credit		
Desired Qualifications	Familiarity with: - design by CAD software; - data analysis with MATLAB/Python; - programming and building circuits with Arduino. Experience with the following is encouraged: - hands-on fabrication; - implementing closed-loop control; - FEA.		

Project Name:	A Lighter, More Transportable Vine Robot Setup	**Project ID:**	R008
Supervisor:	Laura H Blumenschein	**Number of Positions**	1
Project Description:	- Design a smaller, lighter base for Vine Robots (https://www.vinerobots.org/). - Reimagine the Vine Robot setup by streamlining and making it more convenient to transport. - Prepare new Vine Robot setup for presentation to a wider public audience.		
Final Deliverables:	Prototype of device; end of semester presentation		
Weekly Working Hours	10		
For Credits/Pay	Credit		
Desired Qualifications	Familiarity with: - design by CAD software; - programming and building circuits with Arduino. Experience with the following is encouraged: - hands-on fabrication;		

Project Name:	Materials Testing in Soft Robots	**Project ID:**	R009
Supervisor:	Prof. Laura Blumenschein	**Number of Positions**	1
Project Description:	Testing how material properties affect the ability of soft growing robots (vinerobots.org) to move by growing. Will be continuing a previous project with an experimental setup. Project will primarily consist of manufacturing growing robots with new materials, 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, Ardiuno or electronics experience preferred		

PURDUE UNIVERSITY | Mechanical Engineering

Project-based research

Project Name:	MSRAL Research	**Project ID:**	R010
Supervisor:	David J. Cappelleri	**Number of Positions**	3-4
Project Description:	The Multi-Scale Robotics & Automation Lab (MSRAL) performs cutting-edge research on robotic and automation systems at various length scales: macro-scale (cm to m), meso-scale (~100's of µm to a few mm's), and micro-scale (10's of µm to 100's of µm. MSRAL has projects on multi-scale robotic manipulation, automation, and assembly, mobile micro robotics, micro aerial and ground vehicle design & control, medical robotics and devices, agricultural robotics, and space robotics. See more here: https://youtu.be/b-Ge1tEr_DQ		
Final Deliverables:	Final report; Project dependent deliverables may include a working prototype/demonstration		
Weekly Working Hours	10 hours/week		
For Credits/Pay	For credit		
Desired Qualifications	Junior standing or higher; Experience with robotics, mechantronics, 3D printing, electronics, and programming is preferred.		

PURDUE UNIVERSITY | Mechanical Engineering

Project-based research

Project Name:	Robotic manipulation of silicon microscantilever mounting chips	**Project ID:**	R011
Supervisor:	Ryan Wagner	**Number of Positions**	1 to 4
Project Description:	Atomic force microscopy (AFM) is an important scientific tool in many research areas ranging from nanotechnology, material science, and biology. It is used in diverse applications such as atomic resolution imaging of crystalline lattices, mapping dopant concentration of transistors, and measuring the mechanical properties of living cells. AFM functions by moving a sharp tip mounted on a silicon microcantilever across a surface. The quality of the resulting measurements are strongly dependent on the status of the AFM cantilever tip. Any wear or contamination of this can result in poor measurement quality. As a result of this, it is often desirable to repeat a measurement with several different tips. The goal of this project will be to design and built a robotic system for handling the silicon chips on which typical AFM microcantilevers are mounted. This system should be compatible with the geometric constraints of most common AFMs and capable of moving the chip into and out of the AFM. A robotic arm combined with a suction-based holder is a potential candidate design, but other system configurations can be considered.		
Final Deliverables:	Written and Oral report		
Weekly Working Hours	10 hours per week		
For Credits/Pay	For credits: 3		
Desired Qualifications	Junior or Senior Status		

PURDUE UNIVERSITY | Mechanical Engineering

Project-based research

Project Name:	SmartHab	**Project ID:**	R012
Supervisor:	Shirley Dyke	**Number of Positions**	3
Project Description:	There is growing interest from Space agencies such as NASA and the European Space Agency in establishing permanent human settlements outside Earth. To advance knowledge in the field, the Resilient Extra-Terrestrial Habitat Institute (RETHi) is taking steps to develop technologies that will enable resilient habitats in deep space, that will adapt, absorb and rapidly recover from expected and unexpected disruptions without fundamental changes in function or sacrifices in safety. To study, demonstrate, and evaluate the technologies developed in pursuit of this mission, a multi-physics cyber-physical testbed is being founded at the Ray W. Herrick Laboratories at Purdue University. The testbed will consider a combined virtual and physical habitat system and will aim to emulate the extreme temperature fluctuations that happen in deep space. We also aim to consider design trade-offs aimed toward the goals of resilience. Thus, we have also established a modeling platform to support rapid, stochastic simulations of habitat systems to quantify the space architectures that enhance resilience. These might consider the important features of the robots, the sensors, and the structure itself that make the habitat resilient. We plan to include several undergraduate students in these research projects.		
Final Deliverables:	Technical report documenting experimental/simulation results, with potential to be a published manuscript.		
Weekly Working Hours	10 hours/week		
For Credits/Pay	For credits: (# of credits) 3 units For Pay: (Hourly rate) Vontuntary		
Desired Qualifications	Students should be critical thinkers. Some tasks require strong experimental skills and others require programming skills (Python), CAD skills, and experience in MATLAB/Simulink.		

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Project-based research

Project Name:	Arudino control	**Project ID:**	R013
Supervisor:	Euiwon Bae	**Number of Positions**	2
Project Description:	Applied optics lab is searching for UG student who are interested in developing a portable fluorometer. Track A- 1 student Arduino control of Bluetooth enabled device; Send command and receive data through blutooth enabled device; Inegration of other function through Arduion or other controllers Track B – 1 student Design a fluorescence detection attachment for existing mass-based sensor module. Please speficy which track you are applying to.		
Final Deliverables:	Ensloure protoypte (Mechanical) and sensor prototype (Electrical)		
Weekly Working Hours	5-10		
For Credits/Pay	**For credits: (# of credits) : 3 creidts** For Pay: (Hourly rate) : X Vontuntary : X		
Desired Qualifications	Electrical : Arduino programming experience preferred; If you have some PCB design experience, it's even better		

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Project-based research

Project Name:	Drop in biosensor	**Project ID:**	R014
Supervisor:	Euiwon Bae	**Number of Positions**	1
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.		
Final Deliverables:	Ensloure protoypte (Mechanical) and sensor prototype (Electrical)		
Weekly Working Hours	5-10		
For Credits/Pay	**For credits: (# of credits) : 3 creidts** For Pay: (Hourly rate) : X Vontuntary : X		
Desired Qualifications	Mechanical : CAD and willingness to work at Bechtel innovation center		

PURDUE UNIVERSITY | Mechanical Engineering

Project-based research

Project Name:	Optical testbed	**Project ID:**	R015
Supervisor:	Euiwon Bae	**Number of Positions**	2
Project Description:	Applied optics lab is searching for UG student who are interested in developing a multi-purpose optical testbed for various sensor systems. -Mechanical track (1): Design of testbed and fabrication -Electrical track (1) : Arduino based control of laser and photodiode data acquisition. Please specify which track you are applying to.		
Final Deliverables:	Ensloure protoypte (Mechanical) and sensor prototype (Electrical)		
Weekly Working Hours	5-10		
For Credits/Pay	**For credits: (# of credits) : 3 creidts** For Pay: (Hourly rate) : X Vontuntary : X		
Desired Qualifications	Electrical : Arduino programming experience preferred; If you have some PCB design experience, it's even better		

PURDUE UNIVERSITY | Mechanical Engineering

Project-based research

Project Name:	Portable laboratory	**Project ID:**	R016
Supervisor:	Euiwon Bae	**Number of Positions**	2
Project Description:	Applied optics lab is searching for UG student who are interested in developing a -Mechanical track (1): Design of portable laboratory system; 3-d print and machining -Electrical track (1) : Arduino based system integration. Please specifiy which track you are applying to.		
Final Deliverables:	Ensloure protoypte (Mechanical) and sensor prototype (Electrical)		
Weekly Working Hours	5-10		
For Credits/Pay	**For credits: (# of credits) : 3 creidts** For Pay: (Hourly rate) : X Vontuntary : X		
Desired Qualifications	Electrical : Arduino programming experience preferred; If you have some PCB design experience, it's even better		

PURDUE UNIVERSITY | Mechanical Engineering

Project-based research

Project Name:	Research in laser-based manufacturing and materials processing	**Project ID:**	R017
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: Yes. The number of credits is flexible and can be determined after discussions. For Pay: No. Vontuntary: Yes.		
Desired Qualifications	Good hands-on, material chateracterization and/or machine shop capabilities, etc.		

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Project-based research

Project Name:	Advancing Image Segmentation	**Project ID:**	R018
Supervisor:	Thomas Siegmund	**Number of Positions**	2
Project Description:	In many image processes, it is necessary to segment a picture to extract the features of interest. This is a time and compute intensive process. We will conduct research into fast methods and codes to accomplish such processes		
Final Deliverables:	Instructions and examples to conduct image segmentation		
Weekly Working Hours	3 credits equals 9 hours of commitment.		
For Credits/Pay	For credit		
Desired Qualifications	Interest in working with codes		

PURDUE UNIVERSITY | Mechanical Engineering

Project-based research

Project Name:	Data visualizer development for legged robot platforms	**Project ID:**	R019
Supervisor:	Yan Gu	**Number of Positions**	3
Project Description:	Robotics research often demands a substantial amount of effort in coding and debugging on the physical robot platforms. To help improve the efficiency and effectiveness of such effort, researchers could develop a data visualization interface that allows them to monitor the key data measured from the robot and the environment in real-time and to store the data when needed. Such data could be the center of mass velocity, joint angles, and motor torques of a walking robot, as well as the orientation and belt speed of a rocking treadmill. The goal of this project is to develop a data visualizer that displays (in real-time) and stores the movement and force data read from the physical legged robots and the environment (e.g., a treadmill) during various robot movements (e.g., standing, sitting, and walking). Note that the majority of the data mentioned can already be directly sensed, and the primary focus of this project is to correctly read the sensors and properly display and store their data.		
Final Deliverables:	A data visualizer capable of real-time data display and permanent data storage during legged locomotion experiments on a treadmill. The data of interest includes a physical robot's movement and force data returned by onboard sensors, such as the joint angles, velocities, and torques and the camera readings. The other group of relevant data is the position and motion data of the environment, e.g., the position and orientation of a treadmill on which the robot walks.		
Weekly Working Hours	12hr/student		
For Credits/Pay	Credits		
Desired Qualifications	Basic coding skills with C++ and/or Python		

PURDUE UNIVERSITY | Mechanical Engineering

Project-based research

Project Name:	Machine Learning for Fluid Dynamics	**Project ID:**	R020
Supervisor:	Carlos M Corvalan (Associate Professor, by courtesy)	**Number of Positions**	2-3
Project Description:	Machine Learning for fluid dynamics: This project is about the intersection of new data-science methods and the classical field of fluid dynamics. Data-driven discovery and machine learning provide a new powerful framework that can enhance and even transform current lines of fluid mechanics research and industrial applications. This project will bring together machine learning and engineering mathematics to integrate modeling and simulation of dynamical systems with modern methods in data science. We will discuss and apply recent advances in scientific computing and machine learning that enable data-driven discovery to be applied to a diverse range of fluid systems.		
Final Deliverables:	Working computer codes leveraging machine-learning to solve engineering problems		
Weekly Working Hours	TBD		
For Credits/Pay	For credits: (2-3 of credits) Voluntary		
Desired Qualifications	Background in linear algebra, differential equations and scientific computing are desirable		

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Project-based research

Project Name:	Wave Energy Conversion	**Project ID:**	R021
Supervisor:	David Warsinger	**Number of Positions**	3-4
Project Description:	Wave energy can be captured by devices known as Wave Energy Converters (WEC). The objective of this project is to produce a novel approach to energy conversion and power the process of Batch Reverse Osmosis. This process requires immense pressure to force seawater through a membrane to extract impurities and capture the potable water. Students will be working with fellow undergraduates in developing a WEC design that can compete in the DOE's Marine Energy Collegiate Competition (MECC). Marine energy is a quickly growing industry and has many career opportunities after college. Renewable energy sources will always be sought after but higher efficiencies, lower costs, and more applications need to be researched before novel ideas can perform in the market. Student responsibilities include design conceptualization, prototype manufacturing, instrumentation, calibration, modeling, and testing. www.warsinger.com to learn more. Other projects in the lab may be available.		
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. Students can opt in to presenting in MECC final report. Student efforts will contribute data, graphics, and efforts towards scientific publications.		
Weekly Working Hours	12 hours/week		
For Credits/Pay	3 Credits		
Desired Qualifications	Applicants should have an interest in thermodynamics, water treatment, and sustainability. Applicants with experience in some (not all) of the following are preferred: experimental design and prototyping, manufacturing, Python, LabView, EES, MATLAB, 3D CAD Software, & Adobe Illustrator. Rising Juniors and Seniors are preferred		

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Project-based research

Project Name:	Liquid cooling using microscale heat pipes	**Project ID:**	R022
Supervisor:	Liang Pan	**Number of Positions**	2
Project Description:	Scaling the heat pipes to microscale favors high working efficiency and can potentially offer high peak cooling capability for high power applications, such as cooling of supercomputers or power electronics. Existing microscale manufacturing techniques allow the quick creations of omplicated microflow structures, however the design and testing of the microscale heat pipes are not currently implemented at high heating powers. This project will assemble a team of students to work with current graduate students to design, fabricate and test novel microfluid heat pipes.		
Final Deliverables:	A testing system and measurement results.		
Weekly Working Hours	3 credit hours (10-15 hours work load per week).		
For Credits/Pay	For credits: 3 credits For Pay: $12/hr Vontuntary		
Desired Qualifications	The strong hands-on capabilities with interests in thermal and fluid applications. Students from under-represented minorities (URM) groups are highly encouraged to apply.		

Project Name:	Development of Micro/Nano 3D Printers	**Project ID:**	R023
Supervisor:	Liang Pan	**Number of Positions**	2
Project Description:	Three-dimensional (3D) printing is routinely performed to create micro- and micro-scale structures using different methods, such Stereolithography (SLA), Selective Laser Sintering (SLS), Fused Deposition Modeling (FDM), and Digital Light Process (DLP). Here we will assemble a team to experimentally create a new micro/nano 3D printer with software infrastructure that can support a new operation mode that can expand print envolops by fast stitching of subprints.		
Final Deliverables:	A working microscale 3D printer, including the hardware and control software		
Weekly Working Hours	3 credit hours (10-15 hours work load per week).		
For Credits/Pay	For credits: (# of credits) For Pay: (Hourly rate) Vontuntary		
Desired Qualifications	Applicants expect to have one of the following capabilities. 1. Operation of 3D printers 2. Labview programing 3. Optical experiments		

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Project-based research

Project Name:	Characterization of corn stover for biorefinery feeding predictions	**Project ID:**	R024
Supervisor:	Carl Wassgren (wassgren@purdue.edu)	**Number of Positions**	1
Project Description:	The goal of this project is to characterize the primary particles in pelletized corn stover. Corn stover, which consists of the non-kernel portion of a corn plant, is used to make biofuels. Milled corn stover is often pelleted to facilitate transport and handling. During feeding into a biorefinery, the pelletized material breaks apart into the constituent particles. In this project, we seek to characterize the properties of the milled corn stover found within pelleted material. Specifically, we will focus on property measurements for a model used to predict compression feed screw performance. The student working on this project will: (1) prepare samples of the primary particles found in pelletized corn stover, (2) measure the primary particle size distributions, (3) measure particle densities, (4) measure particle moisture contents, and (5) measure poured and tapped bulk densities. The student will learn how to properly sample particulate material for testing as well as how to operate several laboratory instruments for measuring particle properties. The student working on this project will need to complete the following tasks: (1) Complete laboratory safety training and training on the appropriate processing and characterization equipment. (2) Follow a procedure to get primary particles from the pellets. (3) Obtain the moisture content for the sample to be tested. (4) Measure in triplicate each relevant property. (5) Aid in the analysis of the results. (6) Participate in weekly research group meetings. (7) Help prepare a written report and presentation describing the project effort.		
Final Deliverables:	The project deliverables include: a presentation summarizing the project results and a document describing the corn stover and the methods used to characterize them. The student may also be expected to participate in weekly research group meetings where they will provide short updates (~5 – 10 minutes) on their work.		
Weekly Working Hours	12 h/wk.		
For Credits/Pay	For credits: 3 cr		
Desired Qualifications	≥ second semester sophomore standing; interest in experimental work; effective communication skills		

PURDUE UNIVERSITY | Mechanical Engineering

Project-based research

Project Name:	High-speed 3D imaging for micro-robotics	**Project ID:**	R025
Supervisor:	Song Zhang	**Number of Positions**	1
Project Description:	This project aims at developing a high-speed 3D imaging system for applications in micro-robotics such as micro-force sensing and micro-robot manipulation. Student will be closely working with a graduate student.		
Final Deliverables:	• Software algorithm and documentation		
Weekly Working Hours	• 10 hours / Week		
For Credits/Pay	• Based on discussion with advisor		
Desired Qualifications	• Prior C++ programming skill • Strong hands-on skills • Strong communication skills		

PURDUE UNIVERSITY | Mechanical Engineering

Project-based research

Project Name:	3D Printing Anomaly Detection	**Project ID:**	R026
Supervisor:	Song Zhang	**Number of Positions**	2
Project Description:	Developing an imaging system and software algorithm to detect and correct certain error types in the 3D printing process. Focusing on error types such as overfill, slumping, etc. Project topics include 3D reconstruction of objects, additive manufacturing, optics, and image processing. Undergraduate will closely work with graduate students and other peers regularly.		
Final Deliverables:	• Software algorithm and documentation • Bi-weekly presentation slides		
Weekly Working Hours	• 10 hours / Week		
For Credits/Pay	• Based on discussion with advisor		
Desired Qualifications	• U.S. Citizen • Interested in one or more of the above topics listed • Introductory level experience with 3D printers • Intermediate experience with Matlab		

PURDUE UNIVERSITY | Mechanical Engineering

Project-based research

Project Name:	Robotic grisper control	**Project ID:**	R027
Supervisor:	Song Zhang	**Number of Positions**	2-3
Project Description:	This project aims developing software algorithm to control robotic hand for grasping. • Develop software for basic robotic gripper movement control • Design the motion of the robotic gripper for object grasping • Build modular programs for object detection and classification using 2D and 3D perception information • Integrate perception technologies into object grasping • Improve grasping performance using high-accuracy 3D vision technology		
Final Deliverables:	• Software algorithms and result report • Hardware design and relevant documentations		
Weekly Working Hours	• 10 hours / Week		
For Credits/Pay	• For credits		
Desired Qualifications	• Basic coding capabilities with C / C++ / C# • Familiar with use of Visual Studio and Github (For version control) • Strong communication skills • Capable of conducting experiments by self		

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Project-based research

Project Name:	Automated calibration fixture control	**Project ID:**	R028
Supervisor:	Song Zhang	**Number of Positions**	2-3
Project Description:	This project aims at developing control algorithms for two rotational motors and one translational motor. The current hardware fixture has 1 translational stage but need to identify two rotational motors. Undergrduate students will closely work with graduate students and other ungraduated studenst to on hardware system design and control.		
Final Deliverables:	• Hardware design and relevant documentations • Motor selection and integration • Motor control algorithm on Arduino		
Weekly Working Hours	10 hours / Week		
For Credits/Pay	Based on discussion with advisor		
Desired Qualifications	• Hands-on skills • Took ME375 or a relevant control course to work on the control algorithm development • CAD for hardware design and development		

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Project-based research

Project Name:	iPhone App development	**Project ID:**	R029
Supervisor:	Song Zhang	**Number of Positions**	2
Project Description:	This project aims at developing an iPhone App to measure tree attributes (e.g., diameter, height) using iPhone Lidar and 2D cameras. This project includes App graphical user interface (GUI) design and development, and tree attribute measurement algorithms based on point cloud and 2D images. Undergraduate students will be closely working with a graduate student.		
Final Deliverables:	• Software algorithm and documentation		
Weekly Working Hours	• 10 hours / Week		
For Credits/Pay	• Based on discussion with advisor		
Desired Qualifications	• Prior iOS App development experience is preferrable • Strong hands-on skills • Strong communication skills		

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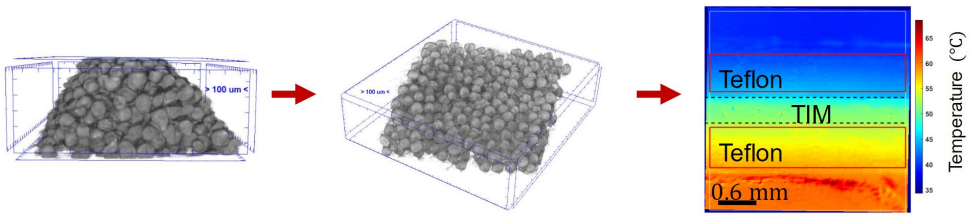
Project-based research

Project Name:	Microprecision Mechanical Testing for Microelectronic Assemblies	**Project ID:**	R030
Supervisor:	Ganesh Subbarayan	**Number of Positions**	2
Project Description:	Micrometer scale interconnections between semiconductor chip and substrate are critical elements of microelectronic systems. Currently, advanced digital systems such as gaming engines and CPUs use microscale solder joints, which are prone to mechanical fracture that may occur under long term thermal cycling or shock loading conditions such as when a cell phone is dropped. Thus, there is a critical need to characterize the mechanical behavior of solder interconnects using both mechanical testing and microstructural analysis. The electronics industry is increasingly considering new solder materials that can be processed at lower temperatures. Student as part of this work, will help develop precision mechanical testers for characterizing micrometer length scale solder joints. The student will then help characterize the mechanical response of low melting temperature solders with additions of Ag and Sb by performing creep, monotonic and fatigue tests. At the end of this project, the students will learn skills to design precision mechanical testers in addition to getting hands-on experience in mechanical testing and microstructural analysis of complex materials.		
Final Deliverables:	Tester design, characterization data		
Weekly Working Hours	10 hours		
For Credits/Pay	Either		
Desired Qualifications	Junior or senior, self-directed, motivated student		

PURDUE UNIVERSITY | Mechanical Engineering

Project-based research

Project Name:	Thermal Conduction in Advanced Composites for Electronics Packaging	**Project ID:**	R031
Supervisor:	Prof. Marconnet https://engineering.purdue.edu/MTEC	**Number of Positions**	1 or more
Project Description:	To enhance the thermal conductivity of polymers used in electronics packaging applications, composites are formed by embedding high thermal conductivity particles in a polymer matrix. The arrangement of the particles within the matrix is critical for achieve high thermal conductivity and uniformity in thermal conductivity. In this project, we will prepare samples with different fabrication parameters and measure their thermal conductivity using high resolution infrared microscopy and/or laser flash thermal diffusivity measurements. In collaboration with Prof. Chawla's group in Materials Engineering, we will use X-Ray Computed Tomography (XRCT) to measure the particle locations and dimensions with microscale precision within the composite structure and predict the thermal conductivity.  *XRCT images of a composite sample (left) before and (right) after squeezing and (right) an infrared thermal map used for estimating thermal conductivity of the composite Thermal Interface Material (TIM) samples.*		
Final Deliverables:	All students will be expected to prepare a final report documenting their methods and results. Depending on the number of students on the project, the following deliverables will be assigned. • Preparation of samples at different compression rates and forces • XRCT data for samples prepared at varying conditions • Thermal data for samples prepared at varying conditions • Numerical model for estimating thermal conductivity based on the extracted XRCT data		
Desired Qualifications	Recommended: • Familiarity with CAD and MATLAB or Python • Thermodynamics Preferred: • Fluid Mechanics • Heat Transfer • Familiarity with finite element simulation tools		

PURDUE UNIVERSITY | Mechanical Engineering

Project Name:	High Resolution Metrology for Confined Boiling	**Project ID:**	R032
Supervisor:	Prof. Marconnet https://engineering.purdue.edu/MTEC	**Number of Positions**	1 or more
Project Description:	The high heat transfer coefficient associated with boiling is attractive for increasing the thermodynamic efficiency of power and refrigeration cycles. For emerging applications such as liquid cooling of next generation electronics, understanding boiling within small confined spaces is required. This project will focus on developing metrology tools to understand the evolution of bubbles and surface temperatures in such applications, as well as the impact of surface coatings on boiling enhancements.		
Final Deliverables:	All students will be expected to prepare a final report documenting their methods and results. Depending on the number of students on the project, the following deliverables will be assigned. • Updated confined boiling test setup enabling thermal imaging through a IR transparent heater • Data for temperatures, heat fluxes, and bubble geometry as a function heater power • Evaluation of different patterned surface coatings on the thermal response during confined boiling		
Desired Qualifications	Recommended: • Thermodynamics Preferred: • Fluid Mechanics • Heat Transfer • Familiarity with MATLAB and LabView		

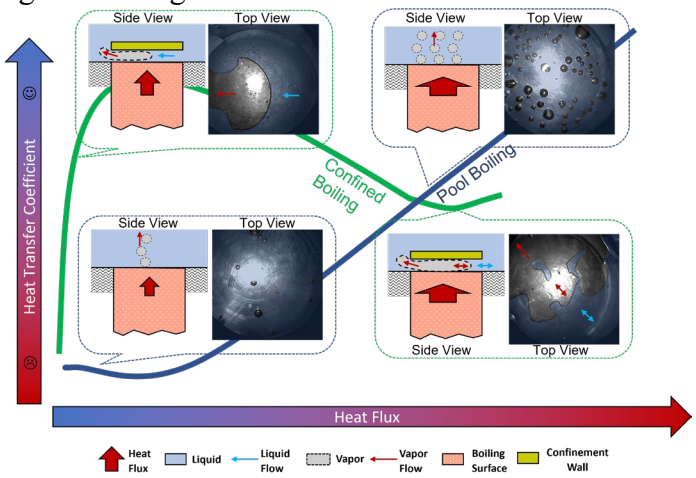


Illustration of regimes of boiling for confined boiling.

PURDUE UNIVERSITY | Mechanical Engineering

Project-based research

Project Name:	Cooling paints	**Project ID:**	R033
Supervisor:	Xiulin Ruan	**Number of Positions**	4
Project Description:	Raditive cooling is a passive cooling technology by reflecting the sunlight and emitting infrared heat, both to the deep space. It has the promise to provide free air conditionging for buidlings and other infrastructures. Learn more about our recent work covered by Purdue News, BBC News, BBC News (TV), CNN, Washington Post, Wall Street Journal, The Guardian, USA TODAY, Science Magazine, New Scientist, Fast Company, PBS News Hour, abc, NBC LX, CBS42, and many more in different countries and languages.and many other news media (Google search "cooling paint Xiulin Ruan"). In this project the undergraduate students will assist postdoctoral fellows or PhD students to design, model, fabricate, and measure nanoparticle-polymer composites for high-performance radiative cooling. These include ultra-white or colored cooling paints. The design involves modeling and machine learning tasks. The identified nanoparticles will be mixed with polymers such as acrylic 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. Students can choose to work on the different components (design and machine learning; fabrications; measurements and field testing).		
Final Deliverables:	Literature and information search, research results, final presentation.		
Weekly Working Hours	7-10		
For Credits/Pay	For Credits		
Desired Qualifications	Junior or senior standing		

Project Name:	Machine learning and atomic level predictions of nanoscale heat transfer	**Project ID:**	R034
Supervisor:	Xiulin Ruan	**Number of Positions**	2
Project Description:	Nanoscale heat transfer, such as thermal conductivity, interfacial conductance, reflectivity, absorptivity, and transmissivity are critical in thermal management of electronic devices and sustainable energy applications. The undergraduate students will assist postdoctoral fellows or PhD students to predict these properties from the atomic structures of materials, using methods based on machine learning, optics, or quantum mechanics.		
Final Deliverables:	Literature and information search, research results, final presentation.		
Weekly Working Hours	7-10		
For Credits/Pay	For Credits		
Desired Qualifications	Junior or senior standing		

PURDUE UNIVERSITY | Mechanical Engineering

Project-based research

Project Name:	Carbon dioxide recycling using biomass	**Project ID:**	R035
Supervisor:	Jay Gore and Aditi Bora	**Number of Positions**	1
Project Description:	Conduct literature search and safe experiments at Zucrow Laboratories to measure carbob dioxide recycling using biomass		
Final Deliverables:	Report including data with uncertainty limits.		
Weekly Working Hours	9 hours total in the laboratory, in the library, and in the study areas.		
For Credits/Pay	For Credit		
Desired Qualifications	Knowledge of or credits taken inME200, ME309, ME315, ME365, and ME375		

PURDUE UNIVERSITY | Mechanical Engineering

Project-based research

Project Name:	Laser Ignition of a Jet	**Project ID:**	R036
Supervisor:	Jay Gore and Sreetam Bhaduri	**Number of Positions**	1
Project Description:	Conduct literature search and safe experiments at Zucrow Laboratories to measure laser energy that leads to ignition of jets as a function of speed and composition.		
Final Deliverables:	Report including data with uncertainty limits.		
Weekly Working Hours	9 hours total in the laboratory, in the library, and in the study areas.		
For Credits/Pay	For Credit		
Desired Qualifications	Knowledge of or credits taken inME200, ME309, ME315, ME365, and ME375		

Project-based research

Project Name:	Mechanical Gravity Battery System for the DC Nanogrid House	**Project ID:**	R037
Supervisor:	Andreas Hoess (PhD Student) and Eckhard A. Groll	**Number of Positions**	3-5
Project Description:	Develop a mechanical battery system that is based on a gravity-elevator concept. Conduct analysis and create a design for implementation.		
Final Deliverables:	System design drawings and bill of materials		
Weekly Working Hours	3 credit hours per person (= 12 hours per week per person)		
For Credits/Pay	For credit		
Desired Qualifications	Sophomore standing (ME 200 and ME 270 completed) or higher		

Project Name:	Small-Scale Vapor Compression Refrigeration System for Liquid Flow Cooling	**Project ID:**	R038
Supervisor:	Haotian Liu (Post-Doc) and Eckhard A. Groll	**Number of Positions**	3-5
Project Description:	Develop a vapor compression refrigeration system with a cooling capacity of approximately 200 W to cool a liquid flowig through appropriate tubing. Conduct analysis, create a design based on available components at the Herrick Labs, and construct system.		
Final Deliverables:	Operational system		
Weekly Working Hours	3 credit hours per person (= 12 hours per week per person)		
For Credits/Pay	For credit		
Desired Qualifications	Junior standing (ME 308 and ME 365 completed) or higher		

PURDUE UNIVERSITY | Mechanical Engineering

Project-based research

Project Name:	SCALE Workforce Development Project	**Project ID:**	R039
Supervisor:	Eric Holloway	**Number of Positions**	2
Project Description:	Students will work with a team to help train highly-skilled U.S. engineers, hardware designers, and manufacturing experts on a microelectronics workforce development project funded by the Department of Defense and managed by NSWC Crane. The particular aspect of this project is to ensure the technical and professional development of technicians at 2-year universities, undergraduates, and graduate students at 4-year universities across the current 17 institutions that are part of Scalable Asymmetric Lifecycle Engagement (SCALE) are trained and prepared to enter the workforce.		
Final Deliverables:	1. Assist in identifying the professional and technical skills required for students at 2-year universities, undergraduates, and graduate students at 4-year universities across the current 17 institutions. 2. Assist in identifying best practices for targeting and developing specific technical skills for students outside of classroom activities. 3. Assist in identifying best practices for targeting and developing specific professional skills for students outside of classroom activities.		
Weekly Working Hours	At least 10		
For Credits/Pay	Either		
Desired Qualifications	ME undergrad; Must be a U.S. citizen due to Department of Defense stipulations.		

PURDUE UNIVERSITY | Mechanical Engineering

Project-based research

Project Name:	Connected Vehicle Analytics	**Project ID:**	R040
Supervisor:	Prof. Darcy Bullock	**Number of Positions**	
Project Description:	The connected vehicle market is estimated to be approximately $66 Billion in 2021, growing to over $180 B by 2027. Purdue University is ingesting approximately 13 billion records per month of connected vehicles driving on Indiana Roads. This data includes 3 second position, speed, acceleration, deceleration, seat belts and pavement roughness. Students participating in this project would have an opportunity to work in one of the following areas: • Developing algorithms to derive traffic signal performance measures for over 2500 traffic signals distributed across Indiana. • Developing interstate performance measures to quantify delay associated with summer work zones and winter storms. • Developing infrastructure report cards that identify areas with deteriorating pavement. • Evaluating Interstate exit trends to identify opportunities for siting electric vehicle charging stations.		
Final Deliverables:	An end of semester poster and/or participating in technical paper for an SAE conference such as COMVEC that will be held in Chicago in Fall 2023.		
Weekly Working Hours	10-15 hours per week.		
For Credits/Pay	Either Credit or for pay is acceptable.		
Desired Qualifications	Experience with R and google cloud tools such “Big Query” would be desirable, but not essential.		

PURDUE UNIVERSITY | Mechanical Engineering

Project-based research

Project Name:	Finite elements simulations of damage in composite materials	**Project ID:**	R041
Supervisor:	Marisol Koslowski	**Number of Positions**	2
Project Description:	The focus of the project to study the response of composite materials to extreme conditions such as shocks and high rate impact.		
Final Deliverables:	Written report		
Weekly Working Hours	9		
For Credits/Pay	For credits: (3)		
Desired Qualifications	ME323 (required), MSE230(preferred), programing experience in python (required)		

PURDUE UNIVERSITY | Mechanical Engineering

Project-based research

Project Name:	Stacking the chip vertically using microporous copper structures	**Project ID:**	R042
Supervisor:	Prof. Tiwei Wei	**Number of Positions**	2
Project Description:	Advanced semiconductor packaging is playing a crucial role to drive system performance and functionality. With the increasing demand for emerging and growing computing needs, three-dimensional (3D) integration with fine-pitch, high-density interconnections, and multi-chip stacks are very promising in the future. Microbump bonding is commonly used in die-level platforms, including die to die, die to interposer, or substrate generally with an underfill. However, the inter-bump shorting, and electrical/mechanical reliability have become the roadblocks for the pitch scaling of the microbumps to a bump size of a few microns. The melted Sn solder has great risk of collapsing or interlocking with the neighboring bumps during the thermocompression bonding (TCB). Microporous structures have great potential to self-align the microrbump using capillary force. Moreover, the molten bump solder can infiltrate into the porous structure, which can create strong mechanical interdiffusion bond. In this proposal, we will address those challenges by introducing microporous structures to the micorbump bonding.		
Final Deliverables:	Achieve a reliable microbump bonding usig porous strcuture		
Weekly Working Hours	15 hours		
For Credits/Pay	For credits		
Desired Qualifications	Solid mechanics, heat transfer background, experiments, great interests in electronics packaging.		

PURDUE UNIVERSITY | Mechanical Engineering

Project-based research

Project Name:	Nano vias for Future 3D memory-on-logic architecture	**Project ID:**	R043
Supervisor:	Prof. Tiwei Wei	**Number of Positions**	2
Project Description:	For data-intensive high-performance applications — such as high-performance graphics accelerators, network devices, high-performance datacenter application-specific integrated circuits (ASICs), and field-programmable gate arrays (FPGAs) — one of the main challenges is the memory "wall." This refers to the growing speed disparity between the central processing unit (CPU) and the memory outside the CPU chip, due to the long interconnect length between the two. 3D stacking memory-on-logic can make the chip-to-chip communication much faster than before. Fine-pitch, high density 3D interconnects technologies are needed to support orders-of-magnitude energy and execution time improvements for future 3D memory-on-logic architecture. The through silicon via (TSV) is the most critical component in 3D stacking memory-on-logic system. Current TSV technology is incapable of meeting requirements for future high interconnection densities due to a size that remains > 1 µm. For the high aspect ratio TSV via etching, a standard Bosch etching process uses alternative etching and deposition processes to create scallop shaped sidewalls along the via. As the TSV diameter scales, the sidewall roughness becomes a more and more dominant factor for the via metallization. Therefore, a modified, scallop-free Bosch etching process has to be developed to minimize the sidewall roughness. This project will investigate the Bosch DRIE etching process, and also via sidewall surface roughness mitigations utilizing oxidation, or chemical etching.		
Final Deliverables:	Fabricate a 1-um diameter through silicon via using Cu electroplating		
Weekly Working Hours	15 hours		
For Credits/Pay	For credits		
Desired Qualifications	Solid mechanics, heat transfer background, experiments, great interests in electronics packaging.		

PURDUE UNIVERSITY | Mechanical Engineering

Project-based research

Project Name:	Joule heating effects for Nanoscale Vias in 3D memory-on-logic stacking System	**Project ID:**	R044
Supervisor:	Prof. Tiwei Wei	**Number of Positions**	2
Project Description:	Heterogeneous 3D integration enables thin device layers to be fabricated independently and then stacked together using through-silicon vias (TSV). 3D stacking memory-on-logic stacking can make the chip-to-chip communication much faster than before. Fine-pitch, high density 3D interconnects technologies are needed to support orders-of-magnitude energy and execution time improvements for future 3D memory-on-logic architecture. The TSV is the most critical component in 3D stacking memory-on-logic system. As the TSV structure layers shrink to the nanoscale, there will be not enough room for the core TSV metal. The shrinkage of the via metal layer will lead to high line electrical resistance, resulting in an extra heat source for Joule heating. In this project, we will target to fundamentally understand the thermal transport inside the nano-TSV as well as help the device/package designers identify the suitable TSV structure systems and material selections which guarantee the lifetime specs for the high-density interconnects. The joule heating effects with different materials systems for the central metal layer (e.g., W, Cu, and Co) and barrier/liner/seed layer (e.g., TiN, TaN, Ti, Co, Ru, Cu, and Ni) will be modeled and benchmarked.		
Final Deliverables:	Perform and gain experience for the thermal modeling in packaging using fenite element modeing approach		
Weekly Working Hours	15 hours		
For Credits/Pay	For credits		
Desired Qualifications	Solid mechanics, heat transfer background, experiments, great interests in electronics packaging.		

Project Name:	Application of Machine Learning Algorithms to the Structural Analysis of aerospace systems	**Project ID:**	R045
Supervisor:	Prof. Fabio Semperlotti	**Number of Positions**	2
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:**	R046
Supervisor:	Prof. Fabio Semperlotti	**Number of Positions**	2
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.		

PURDUE UNIVERSITY | Mechanical Engineering

Project-based research

Project Name:	Shock Tube Hardware	**Project ID:**	R047
Supervisor:	Prof. Chris Goldenstein	**Number of Positions**	1
Project Description:	The Purdue High-Pressure Shock Tube is in need of a pneumatic fill valve to better control the timing of shock wave production in test gases relevant to hypersonic flight.		
Final Deliverables:	Technical report describing shock tube performance with pneumatic fill valve		
Weekly Working Hours	10-15		
For Credits/Pay	Either		
Desired Qualifications	Previously taken thermodynamics and/or fluid mechanics class at Purdue		

PURDUE UNIVERSITY | Mechanical Engineering

Project-based research

Project Name:	Flow visualization in solidification processing	**Project ID:**	R048
Supervisor:	Prof. Matthew Krane (MSE)	**Number of Positions**	1 ME major
Project Description:	This project will be carried out by 2 UGs, one from ME and one from MSE, under direction of graduate student and Prof. Krane. The team (one ME and one MSE undergrads) will build an apparatus for flow visualization in a salt-water solution. The solution is an analogue for a metal alloy and the observation of the flow during freezing will illuminate the formation of defects in metal casting. Many defects in metal casting are caused by the interaction of the growing solid structure and the fluid mechanics. These defects are common causes of failure of metal parts, either in downstream mechanical processing (forging, rolling, extrusion) or during service. Prevention of these flaws by better processing will reduce cost by improving processing yield and save money and lives by making the metal parts more resilient. One example of such defects is *freckles*, formed by fluid flow in the metal alloy mushy zone, which present as long, thin regions in the metal matrix. These regions have compositions far from the average and close to the last metal to freeze and contain a higher volume of secondary phases, which tend to be harder and more brittle than the nominal ally. These features are stress concentrators during deformation processing and service and may cause severe cracking and loss of an ingot or a part. To study their formation and growth, the team will design and construct a benchtop apparatus for observing the flow fields in a transparent metal alloy analogue (a water-ammonium chloride solution), based on similar previous studies. The flow is driven by buoyancy, caused by thermal and compositional changes in fluid density. We will observe the flow behavior as a function of the inclination of the chilled surface to gravity, a configuration common in the processing of nickel-based superalloys. This project is part of larger project in Prof. Krane's research group, funded by a large consumer of nickel superalloys in the aerospace industry in cooperation with a producer of these alloys.		
Final Deliverables:	(1) Design and construction of experimental apparatus; (2) collection of preliminary data (temperatures, photographs of flow); (3) report on design and results.		
Weekly Working Hours	12 hours/week		
For Credits/Pay	Credit (3 hrs) or pay		
Desired Qualifications	ME undergrad; B or better in ME 30800 (Fluid Mechanics)		

PURDUE UNIVERSITY | Mechanical Engineering

Project-based research

Project Name:	Motion analysis by optical reflection	**Project ID:**	R049
Supervisor:	Euiwon Bae	**Number of Positions**	2
Project Description:	This project aims to develop a simple and low-cost motion analysis device utilizing a microcontroller, any positional sensor (either photo-interrupter or proximity sensor), and code an algorithm to extract the trajectory of motion of the mass. This is a two person team project and both member will be tasked to accomplish the same topic. However, sub-task might be split up depending on the background of the applicant.		
Final Deliverables:	Prototype device, Arduino codes, and any algorithms that will be developed		
Weekly Working Hours	5 hrs		
For Credits/Pay	Credit only		
Desired Qualifications	Some background on integrating analog circuit, Arduino controller, and programming skill will be desirable.		

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Project-based research

Project Name:	Automatic Manufacturing for Soft Robots	**Project ID:**	R050
Supervisor:	Prof. Laura Blumenschein	**Number of Positions**	1
Project Description:	Improve a CNC-based heat sealing machine to accurately translate soft robot designs into manufactured prototypes. Current prototypes are built by hand and take significant skill to reproduce accurately. The CNC heat sealer would take a drawing and turn it into a G-code that allows for precise sealing of plastic films in desired patterns. The project would involve improving the CNC-based machine in the following aspects: - Implement a graphical interface to improve the pipeline from pattern drawing to heat sealing. - Design for testing of varied heat-sealing modalities in different materials. - Improve the encasing of electronics and the overall structure of the machine.		
Final Deliverables:	Improved design of the soft robot manufacturing system, end of semester presentation		
Weekly Working Hours	10 hours per week		
For Credits/Pay	For credits: (3)		
Desired Qualifications	Arduino and electronics experience. CAD software proficiency. Previous experience in actuators/machine design. Familiarity with G-code and developing graphic interfaces is preferred but not required.		

Project Name:	Physically programmable robotic structures	**Project ID:**	R051
Supervisor:	Prof. Laura Blumenschein	**Number of Positions**	1
Project Description:	Design a valve switch mechanism to allow physical reprogramming of a soft robot structure. Reprogramming the way air flows in the soft robotic structure can be used to change the behavior or shape of the robot.		
Final Deliverables:	Design of pneumatic switching mechanism, end of semester presentation		
Weekly Working Hours	10 hours per week		
For Credits/Pay	For credits: (3)		
Desired Qualifications	CAD software proficiency. Previous experience in 3D printing and other prototyping skills preferred.		

PURDUE UNIVERSITY | Mechanical Engineering

Project-based research

Project Name:	Planar dynamics of articulated cantilever tubes with tip mass and conveying fluid	**Project ID:**	R052
Supervisor:	Anil K Bajaj	**Number of Positions**	1-2
Project Description:	A system of articulated tubes conveying fluid is studied for its stability and nonlinear behavior. The dynamics of the multi-tube system is formulated with focus on two system parameters: β - the ratio of masses of the tube and the fluid, and ρ – the dimensionless flow rate. For a particular β, as the flow rate is increased, the zero equilibrium becomes unstable leading to buckling or a limit cycle (oscillatory motion centered around the zero equilibrium). For the system with a point mass attached at the free end, a parameter α - the ratio of the mass of the point mass to that of the mass of the tubes and fluid, is introduced. The dynamic stability and nonlinear behavior of the system is investigated with focus on the two-tube case. Numerical solutions to the four first order differential equations are to be developed as the end mass is increased over a critical value. Possible symmetry-breaking bifurcations, period-doubling bifurcations and route to chaos are studied. Poincaré sections of the four dimensional motion can be used to quantify the bifurcations.		
Final Deliverables:	Literature review, Project report including - Coupled Codes/Software and some Animations of Dynamics from ANSYS or COMSOL		
Weekly Working Hours	~ 10hrs/week		
For Credits/Pay	For Credit		
Desired Qualifications	Knowledge of Matlab/ ME 274/ME 365/ME 309/Ansys or Abacus/		

PURDUE UNIVERSITY | Mechanical Engineering

Project-based research

Project Name:	Dynamic Simulations in MEMS and NEMS with Multiphysics Characteristics	**Project ID:**	R053
Supervisor:	Anil K Bajaj	**Number of Positions**	1-2
Project Description:	MEMS and NEMS have become very well studied structural systems with multiple physics including electrostatic actuation (with fringing field effects), stretching nonlinearities due to large displacements, squeeze-film and other damping effects, van der Waal forces fields, etc. Classic examples of these structures are clamped-clamped and cantilever beams with electrodes located on one or both sides (below and above). The beams can be modeled as Euler-Bernoulli beams. With increase in steady actuation levels (static voltages), the structure deforms transversely in a continuous manner, till a sudden jump to large displacement takes place. This phenomenon, called pull-in instability, brings down the beam to contact with the electode(s) causing shorting or disruption of the device function. This behavior can be analytically modeled for thin beams but for thicker structures, and with multiple physical effects, simulations are much more useful for prediction of performance as well for design iteration studies. In this project, after a quick review of the essential literature, the nonlinear governing equations/model of the structure, are to be simulated by two approaches: software tools in Ansys/COMSOL as well as the classical analytical models. The influences of basic design considerations and nondimensional parameters on pull-in instability as well as the dynamic response under resonant excitations will be investigated.		
Final Deliverables:	Literature review, Project report including - Coupled Codes/Software and some Animations of Dynamics from ANSYS or COMSOL		
Weekly Working Hours	~ 10hrs/week		
For Credits/Pay	For Credit		
Desired Qualifications	Knowledge of Matlab/ ME 274/ME 365/ME 323/Ansys or Abacus/		

PURDUE UNIVERSITY | Mechanical Engineering

Project-based research

Project Name:	Simulation and Design in Particle Technology	**Project ID:**	R054
Supervisor:	Aaron Morris	**Number of Positions**	1
Project Description:	The undergraduate researcher will work with the research group in designing and fabricating a device that can separate undesired material from a collection of particles		
Final Deliverables:	The expectation is that the researcher will attend meetings with the group and assist in the design and fabrication of the particle separation device. The final deliverables will be an analysis of the design and system and ideally a minimal viable product.		
Weekly Working Hours	10hrs/wk		
For Credits/Pay	Credit		
Desired Qualifications	ME 263 is required and ME 308 is recommended		

PURDUE UNIVERSITY | Mechanical Engineering

Project-based research

Project Name:	Particle shape and size measurements	**Project ID:**	R055
Supervisor:	Carl Wassgren (wassgren@purdue.edu)	**Number of Positions**	1
Project Description:	The objective of this project is to obtain a statistically significant number of 3D CAD representations of a variety of particles, e.g., corn kernels, wheat kernels, and milled corn stover particles, and analyze their sizes and shapes using common characterization methods. The 3D CAD representations will be obtained from x-ray micro computed tomography (XRCT) measurements. The size and shape analyses will be performed using existing software, although modifications to the CAD files and software may be needed. The data generated from this work will be stored in a database for further use in modeling, such as discrete element method software. Time permitting, the measurements obtained using the XRCT method will be compared to measurements obtained using different techniques, such as sieving or 2D image analysis.		
Final Deliverables:	The project deliverables include: delivery of the experimental data and a report and presentation describing the procedures used and results to generate the data. The student will also be expected to participate in periodic research group meetings where they'll provide short updates (~5 – 10 minutes) on their work.		
Weekly Working Hours	12 h/wk		
For Credits/Pay	For credits: 3 cr		
Desired Qualifications	≥ junior-level standing; interest in experimental work; familiarity with Python programming is a plus; good communication skills		

PURDUE UNIVERSITY | Mechanical Engineering

Project-based research

Project Name:	Powder flow characterization with image analysis	**Project ID:**	R056
Supervisor:	Carl Wassgren (wassgren@purdue.edu)	**Number of Positions**	1
Project Description:	The goal of this project is to use image analysis methods to analyze experiments and simulations of cohesive powder flow in a rotating drum. Steps in the image analysis include: identify the free surface of the powder, calculate the local slope along the free surface, calculate the mean surface slope, and calculate the variance in the surface slopes. The student will have an existing, but incomplete program to use as a starting point. The statistics gathered from the image analysis will be used to compare the accuracy between computer simulations of powder flow and experimental measurements.		
Final Deliverables:	The project deliverables include: delivery of a well-documented computer program and analysis results and a presentation describing the image analysis program and how to run it. The student will also be expected to participate in periodic research group meetings where they'll provide short updates (~5 – 10 minutes) on their work.		
Weekly Working Hours	12 h/wk		
For Credits/Pay	For credits: 3 cr		
Desired Qualifications	≥ second semester sophomore standing; experience with MATLAB or Python programming; good communication skills		