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.		
Option:	For credits		
Option Information:	3 credits		
Desired Qualifications:	Strong analytical skill and desire to learn new experimental and modeling/analysis tools.		

Project-based research

Project name:	Thermal Management of Electronic Systems	**Project ID:**	R002
Supervisor:	Justin Weibel	**Number of positions:**	2
Project Description:	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. The research experience will be in the Electronics Cooling Laboratory of the CTRC, which is located within the Mechanical Engineering Building. Our ongoing projects are aligned with major national initiatives to develop thermal management systems that will enable carbon-neutral electrified aviation and eliminate energy and water use associated with data center cooling. Read more about these initiatives at the links below:https://arpa-e.energy.gov/technologies/programs/ascendhttps://arpa-e.energy.gov/technologies/programs/coolerchips		
Final Deliverables:	Depends on project and for credit/pay		
Option:	For credits		
Option Information:	3 credits		
Desired Qualifications:	Projects are open to excellent students with various engineering and science backgrounds.		

Project-based research

Project name:	Realization of meta-material via 3D additive manufacturing	**Project ID:**	R003
Supervisor:	Yung C. Shin	**Number of positions:**	2
Project Description:	Metamaterials are artificial or man-made materials that are crafted to achieve physical behaviors that are not demonstrated by the constituting material in its conventional sense. They are achieved by cumulating the behavior of the unit cell designed into the macro scale and thereby the effects are also translated into the macro scale. Auxetic, acoustic, and electromagnetic metamaterials are the most pondered subjects in the research field as they have large applications/potential.This research is to experimentally exploit the feasibility of building different metamaterials by using 3D additive manufacturing. 3D additive manufacturing provides unprecedented capabilities for building complex 3D structures from CAD drawings. The participating student needs to carry out the following tasks:1. Literature review of related fields.2. Design 3D metastructure and build them using a 3D printer in the lab.3. Characterize the resultant properties of meta-material.4. Optimize process parameters to achieve the best quality and throughput.5. Generate a technical report summarizing all the findings.		
Final Deliverables:	It is expected to submit weekly reports describing the findings and results of the research during the regularly scheduled meetings. A final written report is required for the final grade, which must contain a literature review, design of metal material, 3D printing of the designed structure, all the experimental characterization and analysis results.		
Option:	For credits		
Option Information:	3 credits		
Desired Qualifications:	Sophomore or higher standing with a minimum GPA of 3.4		

Project-based research

Project name:	Data-driven modeling of microstructure- properties relationships for additively manufactured metal parts	**Project ID:**	R004
Supervisor:	Yung C. Shin	**Number of positions:**	2
Project Description:	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 to wide adoption in the industry. This study aims to establish the microstructure-property relationship of AM-built metal parts, which will contribute to the drastic reduction of process lead time and certification of parts. The participating student(s) is expected to establish microstructure-mechanical property relationships by collecting scattered data in the literature, processing microstructure images to extract microstructure information from the literature and AM built samples, and then using a machine learning technique to capture the relationships between microstructure and mechanical properties. In addition, opportunities exist to print actual tensile specimens using the available facilities in the supervisorâ€™s lab, conduct heat treatment, if necessary, carry out microstructure measurements, and perform mechanical testing using a universal testing machine.		
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.		
Option:	For credits		
Option Information:	3 credits		
Desired Qualifications:	Junior or higher standing with a minimum GPA of 3.5.		

Project-based research

Project name:	Nanoscale 3D printing	**Project ID:**	R005
Supervisor:	Xianfan Xu	**Number of positions:**	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 from designing 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		
Option:	Discuss with advisor		
Option Information:	Options and details to be discussed with faculty advisor		
Desired Qualifications:	Mechanical Engineering (or other engineering) Junior or Senior standing with GPA > 3.5, CAD models, knowing Python is a plus. Either for Credit or for pay ($15/hr) will be OK.		

Project-based research

Project name:	Nanoscale Heat Transfer	**Project ID:**	R006
Supervisor:	Xianfan Xu	**Number of positions:**	1
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 Waalâ€™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		
Option:	For credits		
Option Information:	3 credits		
Desired Qualifications:	Mechanical Engineering Junior or Senior standing with GPA > 3.5, having taken ME315 is a plus		

Project-based research

Project name:	Biophysical properties of macromolecules	**Project ID:**	R007
Supervisor:	Arezoo Ardekani	**Number of positions:**	2
Project Description:	The project focuses on curating data such as molecular descriptors from journal articles. Data will be used to train a neural network architecture that can predict the relationship between molecular descriptors and the functionality of molecules. The undergraduate researcher will work on curating data from a collection of journal articles for certain biomolecules. Collecting data would involve manually collecting data from the literature, extracting the values of the molecular descriptors, and evaluating the accuracy of the collected data. The collected data will then be used to train a neural network architecture that can predict the relationship between the molecular descriptors and the functionality of molecules.		
Final Deliverables:	Summary report, as well as presentation to the group		
Option:	For credits		
Option Information:	3 credits		
Desired Qualifications:	Knowledge of Python		

Project-based research

Project name:	Tension transducer for suture in horses	**Project ID:**	R008
Supervisor:	Arezoo Ardekani	**Number of positions:**	3
Project Description:	The project would consist of developing a device to measure the tension on sutures implanted into the respiratory tract of horses. Ideally, tension could be sampled at a high frequency or at specific time points and the device would be wireless. The suture used specifically within the equine airway is large-gauge (large diameter) and, therefore has different material properties; ideally, the device would measure these without interfering directly with the amount of tension on the suture. An ideal device could be implanted for a period of approximately 6 months and be activated as needed for measurements at different time points. The end goal of the project is to aid in the understanding of laryngeal hemiplegia in horses and the â€œtie-backâ€• a surgery that is used frequently to treat laryngeal hemiplegia in racehorses. Mentors are Dr. Arezoo Ardekani from Mechanical Engineering and Dr. Michelle Tucker from Veterinary Clinical Sciences.		
Final Deliverables:	Functional suture tension-measuring device		
Option:	For credits		
Option Information:	3 credits		
Desired Qualifications:	Experience with mechanical testing		

Project-based research

Project name:	Additive manufacturing of soft materials for biomedical applications	**Project ID:**	R009
Supervisor:	Yung C. Shin	**Number of positions:**	2
Project Description:	This study is to explore the additive manufacturing capabilities of novel soft materials such as different polymers, metal + polymers or ceramic + polymers, using a 3D inkjet type printer available in the supervisorâ€™s lab. The student is expected to optimize the process parameters to build successful samples using the selected materials and characterize their geometric accuracy, microstructural and mechanical properties.		
Final Deliverables:	A final written report is required for the final grade, which contains all the experimental results, collected testing results and analysis results.		
Option:	For credits		
Option Information:	3 credits		
Desired Qualifications:	Sophomore or higher standing with the minimum GPA of 3.4, 3D printing experiences are useful, but not required.		

Project-based research

Project name:	SCALE Workforce Development Project	**Project ID:**	R010
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 19 institutions that are part of Scalable Asymmetric Lifecycle Engagement (https://research.purdue.edu/scale/) are trained and prepared to enter the workforce.		
Final Deliverables:	1. Assist in identifying best practices for targeting and developing specific technical skills for students outside of classroom activities. 2. Assist in identifying best practices for targeting and developing specific professional skills related to SCALE certification for students outside of classroom activities.3. Assist in identifying mentoring training materials and activities for students at internships related to studentâ€™s career interests and goals.		
Option:	For credits		
Option Information:	3 credits		
Desired Qualifications:	ME undergrad; Must be a U.S. citizen due to Department of Defense stipulations.		

Project-based research

Project name:	2D Materials	**Project ID:**	R011
Supervisor:	Jong Hyun Choi	**Number of positions:**	2
Project Description:	2D materials show excellent properties for diverse engineering applications including optoelectronics and nanoelectronics as well as energy storage and conversion. The goal of this project is to understand physicochemical properties of 2D materials such as MoS2 and WSe2. The project activities will include manufacturing and characterization.		
Final Deliverables:	Monthly report and final presentation to the group		
Option:	For credits		
Option Information:	3 credits		
Desired Qualifications:	Motivated students with strong GPA		

Project-based research

Project name:	DNA nanotechnology	**Project ID:**	R012
Supervisor:	Jong Hyun Choi	**Number of positions:**	1
Project Description:	DNA nanotechnology uses DNA molecules as engineering building blocks. For example, complex nanoscale architectures can be built from DNA. This project aims to develop novel bio-manufacturing technologies and understand relevant thermodynamics, kinetics and mechanics.		
Final Deliverables:	Monthly reports and final presentation to the group		
Option:	For credits		
Option Information:	3 credits		
Desired Qualifications:	Motivated students with strong GPA		

Project-based research

Project name:	Efficient and sustainable water technology	**Project ID:**	R013
Supervisor:	David Warsinger	**Number of positions:**	4
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 nanotechnology, 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 membranes, light-driven reactions, artificial intelligence control algorithms, and thermodynamic optimization of systems. The students will be responsible for fabricating membranes, building hydraulic systems, modeling thermal fluid phenomenon, analyzing data, or implementing control strategies in novel system configurations. More information here: 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. Student efforts will contribute data, graphics, and efforts towards scientific publications.		
Option:	Discuss with advisor		
Option Information:	Options and details to be discussed with faculty advisor		
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 CA		

Project-based research

Project name:	Resilient Extraterrestrial Habitats	**Project ID:**	R014
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.		
Option:	For credits		
Option Information:	3 credits		
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.		

Project-based research

Project name:	Revolutionary turbines for clean aviation and power	**Project ID:**	R015
Supervisor:	Guillermo Paniagua	**Number of positions:**	2
Project Description:	This project aims to develop radical new turbine concepts for clean propulsion and power generation while addressing fundamental fluid mechanics problems in compressible internal flows. To accurately estimate all the performance figures of merit of a novel turbine, it is necessary to accompany the experimental results with a detailed computational analysis of all the experimental sensors and quantify their distortion in the flow field. This project will deliver the uncertainty of the fused experimental and computational data.		
Final Deliverables:	Report, codes, final presentation		
Option:	For credits		
Option Information:	3 credits		
Desired Qualifications:	Seniors or juniors		

Project-based research

Project name:	Sports Technology	**Project ID:**	R016
Supervisor:	Euiwon Bae	**Number of positions:**	2
Project Description:	Applied optics lab is searching for UG students who are interested in developing measurement systems related to Sports Technology. We are seeking UGs who are interested in using microcontrollers and sensors to provide data for connected sports equipment devices and/or provide data feedback for the athleteâ€™s performance and exercise. This requires some background in utilizing microcontrollers, battery usage, and sensor integration.		
Final Deliverables:	Weekly meeting slides, working prototype, and final report,		
Option:	For credits		
Option Information:	3 credits		
Desired Qualifications:	Electrical : Arduino programming experience preferred; If you have some PCB design experience, itâ€™s even better		

Project-based research

Project name:	Medical Technology	**Project ID:**	R017
Supervisor:	Euiwon Bae	**Number of positions:**	2
Project Description:	Applied optics lab is searching for UG students who are interested in developing measurement systems related to Medical Technology. We are seeking UGs who are interested in using microcontrollers and sensors to provide data for human physiological measurements such as skin temperature, blood pressure, and electrogram. This requires some background in utilizing microcontrollers, battery usage, and sensor integration. For Spring 24, we are aiming to integrate three detection modalities into a single measurement system. Students will work with existing previous prototype devices and design, fabricate an integrated measurement unit.		
Final Deliverables:	Weekly meeting slides, working final prototype, and final report		
Option:	For credits		
Option Information:	3 credits		
Desired Qualifications:	Electrical : Arduino programming experience preferred; If you have some PCB design experience, itâ€™s even better		

Project-based research

Project name:	In vitro micro/milli-fluidic chip design	**Project ID:**	R018
Supervisor:	Euiwon Bae	**Number of positions:**	2
Project Description:	Applied optics lab is searching for UG student who are interested in developing an in vitro mico/millifluidic chip design and fabrication for biomedical application. Project aim is to design a chamber and identify viable manufacturing methods, and fabricate the prototype for testing.		
Final Deliverables:	Weekly update slides, final prototype, and final report		
Option:	For credits		
Option Information:	3 credits		
Desired Qualifications:	Experience in CAD, material, fluidics, and machining is preferred		

Project-based research

Project name:	Microplastic detection from enviroment	**Project ID:**	R019
Supervisor:	Euiwon Bae	**Number of positions:**	1
Project Description:	Applied optics lab is searching for UG students who are interested in conducting research in the area of microplastic detection. The topic will be conducting a critical review of the research journal paper, evaluating the strengths and weaknesses of the methods, and proposing a new method and/or design of an instrument that can detect microplastic particles in large volumes of samples such as water or drink. No physical prototype will be built at this stage.		
Final Deliverables:	Weekly update slides, final design review, and final report		
Option:	For credits		
Option Information:	2 credits		
Desired Qualifications:	Need to read many papers and tablulate/summarize the topic; need to do a critical review of the subject matter.		

Project-based research

Project name:	Application of Machine Learning Algorithms for Structural Analysis and Material Design of aerospace systems	**Project ID:**	R020
Supervisor:	Fabio Semperlotti	**Number of positions:**	2
Project Description:	In recent years, machine learning and artificial intelligence algorithms have been rapidly expanding to computational mechanics. 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).		
Option:	For credits		
Option Information:	3 credits		
Desired Qualifications:	Juniors and seniors. Interest in solid mechanics and dynamics. Helpful skills: Matlab, Python, Finite Elements.		

Project-based research

Project name:	Research in laser-based manufacturing and materials processing	**Project ID:**	R021
Supervisor:	Benxin Wu	**Number of positions:**	4
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 related to laser-based additive and/or substractive manufacturing.		
Final Deliverables:	Students will be evaluated based on the quantity, quality and difficulty of the work performed. The exact form of deliverables depends on the actual topic(s) in which the student is involved.		
Option:	For credits		
Option Information:	3 credits		
Desired Qualifications:	Good hands-on, material characterization and/or machine shop capabilities, etc. The number of credits is flexible and can be determined after discussions.		

Project-based research

Project name:	Mechanical Engineering Educational Research	**Project ID:**	R022
Supervisor:	Eric Holloway	**Number of positions:**	2
Project Description:	Are you interested in how Mechanical Engineers are educated and the processes of learning associated with learning to become an engineer? This research utilizes various educational methods to take a deeper dive into how students learn various aspects of Mechanical Engineering with the goal of improving how engineers are educated.		
Final Deliverables:	Multiple projects are available, and deliverables will depend on a student's interests and skills. Students will learn various quantitative and qualitative methods, working with a graduate student and faculty advisor. Project deliverables will be discussed with students at the start of the project.		
Option:	For credits		
Option Information:	3 credits		
Desired Qualifications:	Juniors or Seniors, ideally those looking to go to grad school, those interested in learning education methods that complement their technical skills		

Project-based research

Project name:	Mechanical analysis of individual cells with atomic force microscopy	**Project ID:**	R023
Supervisor:	Ryan Wagner	**Number of positions:**	2
Project Description:	Atomic force microscopy (AFM) is a tool that can probe mechanical forces between a sharp tip and a sample. In this project, we will analyze AFM force vs indentation curves on different classes of cells. The goal is to understand how the mechanical properties of cells change in response to disease or injury. The initial AFM data set for this project will be generated by collaborators and shared with the undergraduate student(s). The specific project aim will be to investigate the use of different contact mechanics models to interpret the force indentation data. This will consist of first doing a literature review to understand the nature of these models. After the literature review is complete, curve-fitting routines for selected models will be implemented within a Python programming environment. This Python code is the main project deliverable and will be archived for use by other students in the lab group. If this first project phase is successfully completed, an expanded AFM data set on additional cell samples will be collected and analyzed.		
Final Deliverables:	Python analysis code and a final project report		
Option:	For credits		
Option Information:	3 credits		
Desired Qualifications:	Junior or Senior status with some programming experience		

Project-based research

Project name:	Vibrating piezoelectric membranes for water filtration applications	**Project ID:**	R024
Supervisor:	Ryan Wagner	**Number of positions:**	2
Project Description:	A piezoelectric is a material where an externally applied voltage causes an internal strain. Such materials have many applications in areas such as microelectronics, sensors, actuators, non-destructive testing, metrology, and time keeping. Most piezoelectrics are ceramic materials; however, there are a few crystalline polymers that experience the piezoelectric effect. The most common of these polymers is Polyvinylidene fluoride (PVDF). In this project we will investigate using piezoelectric PVDF membranes for water filtration. The idea is that by vibrating the membrane using the piezoelectric effect we can change the filtration properties of the membrane to selectively stop or pass different types of particles. The first part of this project will consist of a literature review on the physics and current landscape of using piezoelectric membranes for filtration applications. This will be followed by COMSOL based finite element simulations of the membrane response. The simulations will help in developing a better understanding of how the membrane is expected to move under an applied voltage. If these first two project phases are successful, then we will plan and perform vibration analysis experiments on piezoelectric PVDF membranes and compare the results to the COMSOL simulations.		
Final Deliverables:	A final written and oral project report		
Option:	For credits		
Option Information:	3 credits		
Desired Qualifications:	Junior or Senior status with an interest in finite element simulations		

Project-based research

Project name:	Thermal Management and Thermal Systems (Industrial Heat Pumps; Military Vehicles; Data Centers)	**Project ID:**	R025
Supervisor:	Davide Ziviani	**Number of positions:**	3
Project Description:	Thermal management is needed in different applications. Research projects within Center for High Performance Buildings (CHPB) and funded by Federal agencies (DOE & DoD) aim at tackling problems related to high temperature heat pumps (US DOE IEDO), commercial heat pumps with natural refrigerants (US DOE BTO), transport vehicles for military applications (US DoD/SERDP) as well a data centers (ARPA-E COOLERCHIPS program). Research will be conducted at the Ray W. Herrick Laboratories, the largest academic HVAC lab.		
Final Deliverables:	Weekly research progress short presentations and a final summary report; possible contributions to Conference papers		
Option:	Discuss with advisor		
Option Information:	Options and details to be discussed with faculty advisor		
Desired Qualifications:	Projects are open to students with various engineering and science backgrounds. Preferred knowledge of thermodynamics and Python (or C++). Either for Credit or for pay will be acceptable depending on the skill levels and time commitment.		

Project-based research

Project name:	Thermometers, Strain Gauges and Defect Detectors for Semiconductors using Light	**Project ID:**	R026
Supervisor:	Thomas Beechem	**Number of positions:**	3
Project Description:	Who we areâ€¦ Specere is a latin word that means â€œto look or behold.â€• Thatâ€™s what we do. We look, explore, and examine different ways to: (1) move energy with light and (2) get information from light. More specifically, we are a light lab employing infrared physics to create spectroscopic, thermal, and sensing solutions.Research Topic, Semiconductor Sensing: Semiconductor chips are some of the most technologically advanced machines humanity has ever made. Like any complex machine, they break. Methods for predicting where they will break and why they have broken are therefore necessary. You will help us make the thermometers, strain gauges, and â€œdefect detectorsâ€• that are up to the task using some of the worldâ€™s most advanced semiconductor characterization tools that we develop here at Purdue.Whatâ€™ Youâ€™ll Do: Team members will be responsible for performing spectroscopic measurements of next generation semiconductor materials, devices, and packages. Specifically, you will use Raman (sounds like but is not the noodle) and photoluminescence (fancy for glow in the dark) to image the temperature, stress, and presence of defects in everything from commercial logic chips made by Intel to materials being considered for next generation memory devices. Direct mentoring from Dr. B will build your skills in advanced spectroscopic tools (Raman, photoluminescence), coding, technical communication and professional development. 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 â€œmeeting slideâ€• deck outlining research progress through term.		
Option:	For credits		
Option Information:	3 credits		
Desired Qualifications:	We look for motivated and hard-working undergraduates having both strong aspirations for post-graduate studies as well as those that are just considering the possibility of grad school. All applicants should be capable of working independently while effec		

Project-based research

Project name:	Engineering and Public Health	**Project ID:**	R027
Supervisor:	Francisco Montalvo	**Number of positions:**	2
Project Description:	Through our partnership with the Pan-American Health Organization (a branch of the WHO), our research focuses on global health and the adoption of water quality innovations, namely the implementation of point-of-use (POU) filters in public health clinics in sites across Latin America. By employing a translational research framework, we are integrating research questions focused on the efficacy of POU technologies, with applied and operational research, seeking a better understanding of these interventions and the factors affecting ongoing technology translation processes within the local public health systems. The project will deliver a final report to local government and NGOs stakeholders on the feasibility of the implementation of POU technology in their region.		
Final Deliverables:	The undergraduate student researcher(s) will collaborate with other team members in various phases of the project including literature reviews, experimental setups, gathering lab data, and quantitative and qualitative survey analysis.		
Option:	Discuss with advisor		
Option Information:	Options and details to be discussed with faculty advisor		
Desired Qualifications:	Interest in global health and international development. Affinity with hands-on lab work, and data processing using Excel and/or Python.		

Project-based research

Project name:	Helping ultrasound transmit through barriers such as skul	**Project ID:**	R028
Supervisor:	Junfei Li	**Number of positions:**	2
Project Description:	Ultrasound is a versatile and essential medical tool used for diagnosing and monitoring a wide range of medical conditions. For example, ultrasound imaging has been a non-invasive method to help us see what's inside the body. High-intensity focused ultrasound has been developed as a blade to remove bad tissues without opening the body. However, the application of ultrasound techniques to the brain has been limited because our skull blocks most of the waves. The ability to transmit ultrasound through the skull is particularly important when assessing and treating conditions within the brain, allowing for non-invasive imaging and potential therapeutic applications. This project aims to develop structures to help ultrasound transmit through barriers, such as skulls.		
Final Deliverables:	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, proposed method and theoretical model, simulation results, and some initial experimental results.		
Option:	For credits		
Option Information:	3 credits		
Desired Qualifications:	Mechanical Engineering Junior or Senior standing with GPA > 3.5, having taken ME413 is a plus		

Project-based research

Project name:	MSRAL Research	**Project ID:**	R029
Supervisor:	Dave Cappelleri	**Number of positions:**	3
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 (~100â€™s of Î¼m to a few mmâ€™s), and micro-scale (10â€™s of Î¼m to 100â€™s of Î¼m. 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		
Option:	For credits		
Option Information:	3 credits		
Desired Qualifications:	Junior standing or higher; Experience with robotics, mechatronics, 3D printing, electronics, and programming is preferred.		

Project-based research

Project name:	Nanostructured Membrane Heat Exchangers for Efficient Air Conditioning and Drying	**Project ID:**	R030
Supervisor:	David Warsinger	**Number of positions:**	2
Project Description:	Buildings consume over 41% of the energy in the US, and space cooling is a large portion of this energy usage. Thus, there is a great need for energy efficient cooling technologies to help improve the efficiency of buildings. The Membrane Heat Exchanger, developed by our lab, is the most efficient membrane-based air conditioning process proposed to date. It achieves this great efficiency enhancement by using nanostructured, water vapor selective membranes to filter water vapor out of air before cooling so that cooling systems do not have to waste energy on condensing the water vapor in air. The device we are developing offers an exciting solution to an energy question that has existed for decades, and modeling work has shown that the proposed system uses 1.25-4 times less energy to provide the same cooling as conventional systems. Thus, there is great interest and need to further study this technology through experimental validation. This project is also very collaborative in that it involves researchers in the areas of HVAC, material science, and membrane science and will benefit from collaborations with researchers in chemical engineering and environmental and ecological engineering as well.		
Final Deliverables:	The student(s) who joins this lab will be expected to attend weekly lab meetings and sub-group meetings. They will be focusing on membrane fabrication, prototype development, and evaluation. Contributions will include 3D CAD modeling, system control and data acquisition design, membrane material fabrication and testing, and ample opportunities to assist with technical writing efforts (journal articles, conference papers, grant submissions, and patent application). Once the prototype device is de		
Option:	For pay		
Option Information:	12 hours/week, and 15 $/hour		
Desired Qualifications:	- Experience with CAD modeling (CATIA, SOLIDWORKS, etc.) - Experience with LabVIEW control and data acquisition is beneficial. Course-related experience is also very helpful.- Some background in prototype development/manufacturing will be useful-		

Project-based research

Project name:	Fabrication and characterization of micro/nanoscale mechanical and optical devices	**Project ID:**	R031
Supervisor:	Yung C. Shin	**Number of positions:**	1
Project Description:	Two-photon polymerization (TPP) is a unique and prominent additive manufacturing (AM) technique that offers the capability of fabricating true 3D dimensional micro/nanostructures with spatial resolution in the nanometer regime using a femtosecond laser. Given the ever-longing demand for complex three-dimensional microstructures fine features in the semiconductor and biomedical domains, TPP presents an optimal solution.This research involves the design, fabrication, and characterization of optical devices such as flat lenses (metasurfaces), Fresnel lenses, micro lens arrays (MLAs), photonic crystals (PCs) etc. and/or lattice structures which exhibit superior mechanical properties such as super hydrophobic surfaces, mechanical metamaterials, drug delivery devices etc.		
Final Deliverables:	It is expected to submit weekly reports describing the findings and results of the research during the regularly scheduled meetings. A final written report is required for the final grade, which must contain a literature review, design of metal material, 3D printing of the designed structure, all the experimental characterization and analysis results.		
Option:	For credits		
Option Information:	3 credits		
Desired Qualifications:	Junior or higher standing with a minimum GPA of 3.4, Familiarity with CAD is desired, but not required.		

Project-based research

Project name:	Instrumentation of parallel microscale 3D printer	**Project ID:**	R032
Supervisor:	Liang Pan	**Number of positions:**	3
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 parallel micrscale 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		
Option:	Discuss with advisor		
Option Information:	Options and details to be discussed with faculty advisor		
Desired Qualifications:	Junior or Senior in Schoole of ME. GPA > 3.3		

Project-based research

Project name:	Dynamic Micro Heat Pipe	**Project ID:**	R033
Supervisor:	Liang Pan	**Number of positions:**	3
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 complicated 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 report and prototype heat pipe		
Option:	Discuss with advisor		
Option Information:	Options and details to be discussed with faculty advisor		
Desired Qualifications:	Junior and Senior in School of ME. GPA > 3.3		

Project-based research

Project name:	Machine Learning for Engineers	**Project ID:**	R034
Supervisor:	Carlos Corvalan	**Number of positions:**	3
Project Description:	Machine Learning for EngineersThe intersection of data-driven methods, machine learning, and classical engineering is a rapidly growing field with transformative potential. Machine learning provides a powerful framework that can enhance and even transform engineering research and industrial applications.This project will bring together machine learning and engineering mathematics to integrate modeling and simulation of engineering systems, including fluid mechanics and heat transfer, with modern methods in data science. Students 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 engineering systems.		
Final Deliverables:	Final deliverable: Working computer codes that leverage machine learning to solve engineering problems.		
Option:	For credits		
Option Information:	3 credits		
Desired Qualifications:	Background in linear algebra, differential equations and scientific computing are desirable.		

Project-based research

Project name:	Next-Gen Semiconductor chips 3D stacking	**Project ID:**	R035
Supervisor:	Tiwei Wei	**Number of positions:**	2
Project Description:	In the world of advanced computer technology, we're constantly striving to make computers faster and more powerful. To achieve this, we're exploring a new way to connect computer chips - by using small copper structures to stack them on top of each other, which improves their performance.Normally, computer chips are connected using small solder bumps. However, there are issues with this method, such as the bumps occasionally touching each other, causing electrical problems and making the connection less reliable. We're also working on making these bumps smaller.Our solution is to use special copper structures. These structures help the small bumps connect more easily and stay reliable. Furthermore, the solder used for the bumps can fill these structures, creating a strong bond. In this project, we'll explain how these copper structures can make our microchips work better when stacked together.		
Final Deliverables:	1) Attend weekly meeting discussions with mentors and supervisors; 2) Prepare and present a final oral presentation to faculty advisor/mentor. 3) Prepare and submit a final 1-page written report to faculty advisor by the date specified by the faculty advisor. 4) Allocate 10-12 hours per week for three research credits (approximately 4 hours per week for each credit).		
Option:	For credits		
Option Information:	3 credits		
Desired Qualifications:	Interests in semiconductors and enthusiasm for material fabrication and characterizations; Solid mechanics, heat transfer background.		

Project-based research

Project name:	Semiconductor Packaging & Cooling for Next-Gen Wireless Systems	**Project ID:**	R036
Supervisor:	Tiwei Wei	**Number of positions:**	2
Project Description:	In the 21st century, wireless tech, like cellphones and Wi-Fi, has exploded in scale and complexity. But energy efficiency lags behind. By 2030, wireless tech could contribute up to 23% of global CO2 emissions. 5G tech, which uses millimeter wave tech for more bandwidth, increases power usage. To handle this, wide bandgap semiconductors are needed, offering much higher power density. The heat generated, especially in stacked chips, poses problems. To cool high-power chips, we're exploring embedded microjet cooling through advanced glass fabrication, incorporating tiny fluid channels directly into the chips. This innovation is vital for efficient cooling in stacked chips.		
Final Deliverables:	1) Attend weekly meeting discussions with mentors and supervisors; 2) Prepare and present a final oral presentation to faculty advisor/mentor. 3) Prepare and submit a final 1-page written report to faculty advisor by the date specified by the faculty advisor. 4) Allocate 10-12 hours per week for three research credits (approximately 4 hours per week for each credit).		
Option:	For credits		
Option Information:	3 credits		
Desired Qualifications:	Interests in semiconductors and enthusiasm for material fabrication and characterizations; Solid mechanics, heat transfer or CFD, CAD skill		

Project-based research

Project name:	Enhancing Semiconductor Package Reliability through Thermo-Mechanical Modelin	**Project ID:**	R037
Supervisor:	Tiwei Wei	**Number of positions:**	2
Project Description:	Thermal-mechanical modeling plays a pivotal role in the design and optimization of semiconductor chips and packaging systems. In the rapidly evolving world of electronics, where miniaturization and performance enhancement are paramount, understanding the intricate interplay between thermal and mechanical aspects is crucial. Semiconductor chips generate heat during operation, and without effective thermal management, this heat can lead to reduced performance and even catastrophic failures. In parallel, packaging technology, such as flip-chip and wafer-level packaging, has become increasingly sophisticated to ensure reliability and durability. Thermal-mechanical modeling provides a predictive framework to assess the impact of thermal loads, thermal stresses, and mechanical deformations on semiconductor chips and their packaging. Through accurate modeling, engineers and researchers can make informed decisions to enhance the thermal and mechanical performance of these crucial components, ultimately advancing the capabilities of electronic systems.		
Final Deliverables:	1) Attend weekly meeting discussions with mentors and supervisors; 2) Prepare and present a final oral presentation to faculty advisor/mentor. 3) Prepare and submit a final 1-page written report to faculty advisor by the date specified by the faculty advisor. 4) Allocate 10-12 hours per week for three research credits (approximately 4 hours per week for each credit).		
Option:	For credits		
Option Information:	3 credits		
Desired Qualifications:	Interests in semiconductors and enthusiasm for material fabrication and characterizations; Solid mechanics, heat transfer background.		

Project-based research

Project name:	Thermal management for semiconductor chips	**Project ID:**	R038
Supervisor:	Tiwei Wei	**Number of positions:**	2
Project Description:	In the United States, data centers account for approximately 2% of the country's total electricity consumption, and a significant portion of this energy is used for the cooling of high-performance microchips. The objective of these initiatives is to improve data center efficiency and reduce energy consumption, thereby contributing to the global effort to combat climate change.Their strategy revolves around the implementation of a two-phase cooling system, which involves the integration of microchannels filled with liquid directly into the packaging of microchips. When these microchips generate heat, the liquid inside these channels undergoes a phase change, transitioning to a vapor state, which effectively dissipates the heat. Subsequently, this vapor condenses and is recycled to initiate the cooling process anew. This innovative cooling method is particularly well-suited for high-performance semiconductors, such as those commonly found in servers within data centers.		
Final Deliverables:	1) Attend weekly meeting discussions with mentors and supervisors; 2) Prepare and present a final oral presentation to faculty advisor/mentor. 3) Prepare and submit a final 1-page written report to faculty advisor by the date specified by the faculty advisor. 4) Allocate 10-12 hours per week for three research credits (approximately 4 hours per week for each credit).		
Option:	For credits		
Option Information:	3 credits		
Desired Qualifications:	Interests in semiconductors and enthusiasm for material fabrication and characterizations; Solid mechanics, heat transfer , CFD, or CAD, 3D printing.		