Project-based research

Project name:	Design and Fabrication Long Range Oscillating Heat Pipe	**Project ID:**	R001
Supervisor:	Liang Pan	**Number of positions:**	3
Project Description:	Oscillating heat pipes favors high working efficiency and can potentially offer high peak cooling capability for high power applications. Existing manufacturing techniques allow the quick creations of complicated flow structures, however the design and testing of the oscillating heat pipes at high power and long range are not well understood. This project will assemble a team of students to work with current graduate students to design, fabricate and test long range oscillating heat pipes.		
Final Deliverables:	Report and prototype		
Option:	Discuss with advisor		
Option Information:	Options and details to be discussed with faculty advisor		
Desired Qualifications:	Applicants expect to have one or more of the following capabilities. 1. Fabrication skills in machine shop2. Thermodynamics3. Heat transfer		

Project-based research

Project name:	Microscale 3D Printing using Parallel Writings	**Project ID:**	R002
Supervisor:	Liang Pan	**Number of positions:**	3
Project Description:	Three-dimensional (3D) printing is routinely performed by rastering writing in the point-by-point fashion, such Stereolithography (SLA), Selective Laser Sintering (SLS), Fused Deposition Modeling (FDM). Here we will assemble a team to experimentally implement a microscale 3D printer method with software and hardware infrastructure that can support a parallel writing mode fro higher throughput. This is an intermediate step for a 2024 Fall semester project on Microscale 3D Printing using Volumetric and Holography Methods, which will support a new operation mode to directly placing 3D shapes (such as cubes, spheres, or other complex 3D shapes) by using volumetric projection.		
Final Deliverables:	A working microscale 3D printer, including the hardware and control software		
Option:	Discuss with advisor		
Option Information:	Options and details to be discussed with faculty advisor		
Desired Qualifications:	Applicants expect to have one of the following capabilities. 1. Operation of 3D printers2. Use of CAD to create 3D geometries3. Programing4. Basic digital circuits and the use of oscilloscope and other electronics. 5. Machining		

Project-based research

Project name:	Machining Learning Model for Prediction of Mechanical Properties of Metal Parts	**Project ID:**	R003
Supervisor:	Yung Shin	**Number of positions:**	2
Project Description:	This study aims to establish the microstructure-property relationship of additively 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 using optical microscopy or scanning electron microscoy, 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:	Some background on mechanics of material with GPA higher than 3.4.		

Project-based research

Project name:	Realization of meta-material via 3D additive manufacturing	**Project ID:**	R004
Supervisor:	Yung 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 exploit the feasibility of building different metamaterials by using 3D additive manufacturing. 3D additive manufacturing provides unprecedented capabilities for building complex 3D lattice structures from CAD drawings.		
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 must contain a literature review, design of metal material, 3D printing of the designed structure, any analysis results and the experimental characterization results.		
Option:	For credits		
Option Information:	3 credits		
Desired Qualifications:	Sophomore or higher with a GPA of 3.4 or higher		

Project-based research

Project name:	Design,fabrication and characterization of micro/nanoscale mechanical and optical devices	**Project ID:**	R005
Supervisor:	Yung Shin	**Number of positions:**	2
Project Description:	Two-photon polymerization (TPP) by a femtosecond laser is a unique and prominent additive manufacturing (AM) technique, which offers the capability of fabricating true 3D dimensional micro/nanostructures with spatial resolution in the nanometer regime. Given the ever-longing demand for complex three-dimensional microstructures fine features in the semiconductor and biomedical domains, TPP presents a promising 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:	Sophomore or higher standing with the GPA of 3.4 or higher.		

Project-based research

Project name:	FE Models for Cellular Materials	**Project ID:**	R006
Supervisor:	Thomas Siegmund	**Number of positions:**	1
Project Description:	Create finite element models of cellular materials. Execute such models with a FE code (ABAQUS)		
Final Deliverables:	Model files; report		
Option:	Discuss with advisor		
Option Information:	Options and details to be discussed with faculty advisor		
Desired Qualifications:	experience with FEA, ABAQUS, ME 489		

Project-based research

Project name:	Porous Materials - Strength and Toughness	**Project ID:**	R007
Supervisor:	Thomas Siegmund	**Number of positions:**	1
Project Description:	Conduct manufacture, microstructure analysis, and mechanical testing on brittle porous materials.		
Final Deliverables:	Samples, protocols		
Option:	Discuss with advisor		
Option Information:	Options and details to be discussed with faculty advisor		
Desired Qualifications:	ME 323		

Project-based research

Project name:	Standard test structure and protocols for in space manufacturing	**Project ID:**	R008
Supervisor:	Luz Sotelo, Salil Bapat, Michael Sealy, Ajay Malshe	**Number of positions:**	4
Project Description:	Researchers will work on collaborative projects involving: 1) Design, manufacturing, and characterization of a test or set of test structures for in-space manufacturing; 2) Space-viable test protocols development and ground demonstrations for relevant destructive and nondestructive testing methods; 3) Multi-material manufacturing of regolith-metal and regolith-polymer samples using a variety of additive manufacturing; 4) Integration of analytical, numerical, and finite element modeling and analysis of test structure performance with experimental data.		
Final Deliverables:	1) Documentation: 1 final written report and presentation*, documented test structure(s) design and CAD files, test structure samples, experimental/test protocols, data collected, documented data analysis scripts. * Researchers will use PPT slides to share and discuss weekly progress. The cumulative weekly presentation slides will be part of the final presentation after the research period. 2)Dissemination: Researchers are encouraged to deliver a technical oral or poster presentation		
Option:	Discuss with advisor		
Option Information:	Options and details to be discussed with faculty advisor		
Desired Qualifications:	1) ME 263 and ME 323 or equivalent. 2) Experience in ONE OR MORE of the following: a) Manufacturing and additive manufacturing processes; b) Materials testing and characterization; c) CAD, programming, and DAQ; d) Analytical/FE modeling		

Project-based research

Project name:	Mechanics of battery materials and conducting polymers	**Project ID:**	R009
Supervisor:	Kejie Zhao	**Number of positions:**	3
Project Description:	The undergrad research projects will work on mechanics modeling and experimental characterization of battery materials and conducting polymers.		
Final Deliverables:	Literature review and a group presentation		
Option:	Discuss with advisor		
Option Information:	Options and details to be discussed with faculty advisor		
Desired Qualifications:	Interested in mechanics of materials; self-motivated		

Project-based research

Project name:	Scientific Machine Learning	**Project ID:**	R010
Supervisor:	Carlos M Corvalan	**Number of positions:**	2
Project Description:	The 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 dynamical systems 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:	Working computer codes leveraging 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:	active rheology	**Project ID:**	R011
Supervisor:	Arezoo Ardekani	**Number of positions:**	4
Project Description:	Microrheology has emerged in the past few decades as an effective technique forunderstanding the mechanical properties of various materials and systems. This project seeks to develop a form of active microrheology to characterize the viscoelastic properties of biological matter and cells.		
Final Deliverables:	presentation, report, prototype		
Option:	For credits		
Option Information:	3 credits		
Desired Qualifications:	ME 263		

Project-based research

Project name:	Manufacturing and Controlling Arrays of Polymer-Based Actuators	**Project ID:**	R012
Supervisor:	Alex Chortos	**Number of positions:**	2
Project Description:	Polymer-based actuators can be fabricated over large areas in complex form factors, making them suitable for applications in human-machine interfaces and large-area devices. Creating and operating these devices is an interdisciplinary challenge that includes understanding the materials, mechanics, and controls, providing opportunities to get involved in one or more aspect of the system development.		
Final Deliverables:	Final report (~6-10 pages) on research accomplishments.		
Option:	For credits		
Option Information:	3 credits		
Desired Qualifications:	Desirable expertise include experience with 3D printing, polymers, or electronics.		

Project-based research

Project name:	Synthesis of novel high-temperature oxidation resistant transition metal carbides	**Project ID:**	R013
Supervisor:	Babak Anasori	**Number of positions:**	2
Project Description:	To apply materials in extreme environments, such as extreme temperatures (>3000 Â°C) or extreme reactive environments (oxidation-based material ablation) for modern hypersonics or extraterrestrial exploration requires todayâ€™s engineers and scientists to design materials with careful attention paid to every atom. In the Anasori Lab, we are exploring novel synthetic methods to tailor ternary transition metal carbides, known as MAX phases, for compositions which survive the most extreme conditions possible in our universe. The students in this project will be working with graduate students and postdocs to get fully trained in materials synthesis and characterizations and be able to conduct the research. This summer research experience will be split between Purdue University in Indianapolis and West Lafayette to 1) synthesize the precursor phases and 2) explore their high-temperature properties.		
Final Deliverables:	A final report on the progress of the materials synthesis and characterization.		
Option:	For credits		
Option Information:	3 credits		
Desired Qualifications:	This project will be heavily done through hands-on experience in a wet chemistry lab, so the applicants should either have experience with or be willing to learn materials synthesis and characterization techniques. We will look for applicants with strong		

Project-based research

Project name:	MSRAL Research	**Project ID:**	R014
Supervisor:	Dave Cappelleri	**Number of positions:**	2
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, mechantronics, 3D printing, electronics, and programming is preferred.		

Project-based research

Project name:	Synthesis of novel two-dimensional MXenes and their colloidal stability in green solvents	**Project ID:**	R015
Supervisor:	Babak Anasori	**Number of positions:**	2
Project Description:	Scaling up two-dimensional MXenesâ€™ production for diverse applications necessitates the development of stable colloidal dispersions. By conducting experiments to understand the dispersion of MXenes in different green solvents, we aim to synthesize novel MXenes and investigate their colloidal stability using UV-Vis-NIR spectroscopy. To fundamentally understand the stability of MXenes in a library of green solvents, our strategy involves designing a systematic study over time and elevated temperatures (~ 80 Â°C). In Anasori Lab, we are dedicated to exploring innovative approaches for the novel MXene synthesis and studying their properties. This summer research opportunity will involve a combination of activities, including synthesizing novel MXenes and investigating their colloidal stability in different green solvents.		
Final Deliverables:	A final report on the progress of the materials synthesis and characterization.		
Option:	For credits		
Option Information:	3 credits		
Desired Qualifications:	This project requires hands-on experience in a wet chemistry laboratory. Candidates should have experience in materials synthesis and characterization techniques or be willing to learn.		

Project-based research

Project name:	Efficient and sustainable water technology	**Project ID:**	R016
Supervisor:	David Warsinger	**Number of positions:**	3
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. Our labâ€™s project aims to explore nanofabricated membranes, light-driven reactions, artificial intelligence control algorithms, and thermodynamic optimization of systems. Our projects include hybrids of reverse osmosis desalination with renewable energy (solar, wind, and hydro), as well as other topics such as filtration, water treatment, and water vapor harvesting. The student(s) will be responsible for fabricating membranes, building hydraulic systems, modeling thermal fluid phenomenon, analyzing data, and/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:	For credits		
Option Information:	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 CA		

Project-based research

Project name:	Research in laser-based manufacturing and materials processing	**Project ID:**	R017
Supervisor:	Benxin Wu	**Number of positions:**	3
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 subtractive 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. Students can choose "For credit" (with a flexible number of credits) or "Volunteer" option.		
Option:	For credits		
Option Information:	3 credits		
Desired Qualifications:	Good CAD, hands-on, material characterization and/or machine shop capabilities, etc.		

PURDUE UNIVERSITY | Mechanical Engineering

Project-based research

Project Name:	Measurements of Corn Damage Model Properties	**Project ID:**	R018
Supervisor:	Carl Wassgren	**Number of Positions**	1
Project Description:	The objective of this project is to measure properties used in corn kernel damage models. Approximately 10% of corn kernels are lost due to mechanical damage during harvesting and handling. To reduce this loss, damage models have been integrated into Discrete Element Method (DEM) models of harvesting and handling equipment. Calibration experiments are required to determine the input parameters into these models. The student working on this project will measure the compression and impact damage parameters for corn kernels having different moisture contents. The experiments will involve conditioning the kernels to a particular moisture content, measuring the compaction damage parameters using a materials testing system, and measuring the impact damage parameters using a rotary impact tester. A large number of repeat experiments are needed to obtain good statistical data. The student will receive training on all of the required equipment and methods for analyzing the resulting data. The experiments will be performed in the ABE Building. These data will ultimately be used in DEM simulations for predicting damage in combine-harvesting equipment.		
Final Deliverables:	The project deliverables include: a presentation summarizing the project procedures and results and the measured data. The student will also be expected to participate in weekly research group meetings where they'll provide short updates (~5 – 10 minutes) on their work.		
Weekly Working Hours	9 h/wk		
For Credits/Pay	For credit: 3 cr		
Desired Qualifications	≥ second semester sophomore standing; interest in experimental work; good communication skills; GPA > 3.0		

PURDUE UNIVERSITY | Mechanical Engineering

Project-based research

Project Name:	Performance of a Continuous Shear Gap Granulator	**Project ID:**	R019
Supervisor:	Carl Wassgren	**Number of Positions**	1
Project Description:	The objective of this project is to investigate the performance of and potential improve the design of a novel continuous shear gap wet granulator. Wet granulation is a common unit operation in the production of particulate-based products such as pharmaceuticals, food products, laundry detergents, agricultural fertilizers, and other chemical products. In wet granulation, a liquid is mixed with a dry powder to form granules, which generally have better flow properties and are less susceptable to dusting and segregation. Often the wet granulation process is performed in a batch unit operation and the process performance is tuned empirically. In this project, we investigate wet granulation performance in a new continuous granulator design. The granulator, known as the Continuous Shear Gap Granulator (C-SGG) and designed and mostly assembled in a previous undergraduate research project, offers the potential to streamline the wet granulation unit operation by subjecting material to a more consistent flow field than a typically high shear wet granulator. The student working on this project will need to complete the following: (1) Integrate drive motors on the granulator (some motor control programming will be needed). (2) Perform granulation experiments relating operating parameters (feed rate, rotor speed, liquid feed, and formulation characteristics) to granule characteristics (size and shape distributions). (3) Make design modifications, if needed, to improve the C-SGG performance. (4) Present the C-SGG design and performance with industry visitors. The student will receive training for making granule characterization measurements.		
Final Deliverables:	The project deliverables include: a presentation summarizing the project procedures and results and the measured data. The student will also be expected to participate in weekly research group meetings where they'll provide short updates (~5 – 10 minutes) on their work.		
Weekly Working Hours	9 h/wk		
For Credits/Pay	For credit: 3 cr		
Desired Qualifications	≥ second semester sophomore standing; interest in experimental work; good communication skills; GPA > 3.0		