SENIOR DESIGN SHOWCASE 2025

Presented by:

Robert McKee, PhD
Dmytro V Zagrebelnyy, PhD
James P Sawyer, PhD
Farbod Khoshnoud, PhD

- BIOENGINEERING
- MATERIALS SCIENCE AND ENGINEERING
- MECHANICAL ENGINEERING

- May 30, 2025
- HUB Room 302

UCR Marlan and Rosemary Bourns College of Engineering

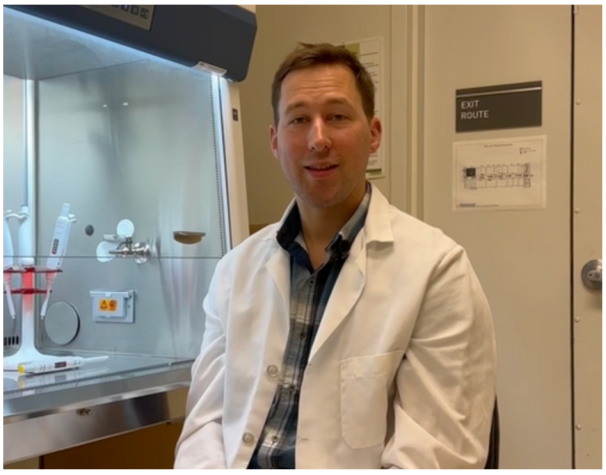
DEAN'S MESSAGE

Among the many learning experiences BCOE provides its students, Senior Design projects play a critical role. The hands-on experiences allow them to sharpen the knowledge and technical skills they've acquired. It provides students the opportunity to apply their innovations to tackle real-world industry problems and engineering challenges. Working in teams and across disciplines while collaborating with industry sponsors and mentors exposes them to the experiences encountered by professional engineers. And lastly, this exercise in developing new ideas, new concepts, and new solutions prepares them for a prosperous and meaningful future.

Sincerely,

Christopher S. Lynch
Dean, Marlan and Rosemary Bourns
College of Engineering
William R. Johnson, Jr. Family Chair

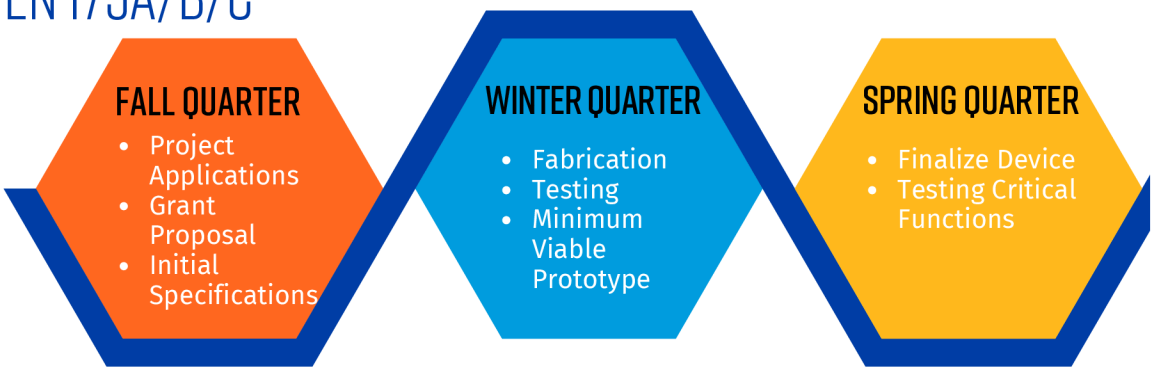
BIOENGINEERING
YEAR-LONG COURSE SERIES



Robert McKee
Assistant Professor of Teaching
Department of Bioengineering

BIEN 175A/B/C is a year-long course series. In the fall quarter, students submit applications to projects and once placed work to ideate an initial design including a grant proposal and initial specifications document while staying within a $1,200 budget. In the winter quarter, student teams work to fabricate and begin testing the functionality of their minimum viable prototype. Finally, in the spring quarter, students finalize their devices and complete thorough testing of critical functions. Throughout the year this course series gives students fundamental coverage of problem definitions and solution concepts, part specifications and justifications, iterative and alternative design, fabrication, statistical analysis, ISOs and FDA regulations, market analysis, SOP writing, proposal writing, project planning and management, and public presentations.

BIEN 175A/B/C



TEAM

Sam Burton
Kelvin Hoang
Henry Rodriguez
Abtin Shafie
Alyssa Shen

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ANEURYSM AWAY: A CELL-SEEDED FLOW LOOP FOR INTRAVASCULAR ANEURYSM DEVICE TESTING

Our project is a cell seeded flow loop designed for intravascular aneurysm treatment device testing. Brain aneurysms pose a 50% mortality rate should they rupture, leading to about 15,000 deaths annually in the U.S. Our device focuses on testing biodegradable flow diverters that have direct contact with endothelial cells under pulsatile flow. A researcher using our flow loop can test their aneurysm treatment device by examining the biodegradation and erosion experienced through an in-vitro simulation. This provides an opportunity for one to observe how patient specific complex geometries may result in variable degradation patterns, affecting the lifespan of the device upon administration within patient treatments.

TEAM

Alejandro Leyva
Edris Saleh
Adrianna Mendoza
Jason Landeros
Angie Espinoza-Carabantes

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AUTOMATED BLOOD CONVERSION

Our project presents an automated system to convert type A blood into type O, the universal donor type. We use an enzyme to remove A-type markers from red blood cells, making them safe for any recipient. Blood flows through a series of chambers where it is mixed, treated, and filtered using pumps and sensors. A custom rocking platform improves mixing and speeds up the conversion process. To ensure safety, we remove leftover enzymes and unconverted cells using magnetic particles and filtration. By turning type A into type O automatically, our system aims to expand the blood supply and reduce compatibility issues in transfusions.

TEAM

Dominik Ďurďovič
Nathan Angelo Fernandez
Christopher Garland
Wilton Phung
Wanqing Yao

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BLOOD ANALYSIS DEVICE

Our device offers a cost-effective, portable blood analysis solution for hematology monitoring. Existing options are either too expensive or lack functionality. We integrate a 635nm laser-based forward scatter system for RBC counting, 570nm and 850nm LEDs with photodiodes for hemoglobin quantification, an Arduino UNO R3 for data acquisition, and a cuvette with PBS-diluted samples. It measures RBC and hemoglobin and calculates hematocrit, MCV, MCH, and MCHC from capillary blood. Performance was validated using red polystyrene beads that mimics the light scattering properties of blood to test our LED and photodiode system.

TEAM

Arya Patel
Parker Yoon
Chelsy Cervantes
Daniel Nguyen

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CARBON MONOXIDE POLLUTANT DETECTANT DEVICE

Carbon monoxide (CO) is a significant occupational hazard, especially for firefighters and industrial workers. Existing sensors measure environmental CO but fail to detect breaches in protective gear. To solve this, we developed a novelty mask that monitors CO levels both environmentally and internally. The internal sensor will monitor CO levels in an individual's breath and help detect potential leaks that an external sensor would overlook. These measurements are set to correspond with respective LED arrays that change behavior in response to increasing CO levels in order to warn users and allow them to evacuate before suffering both short and long term effects from CO exposure.

TEAM

Luca Dobrin
Michael Shih
Jacob Mapa
Jarnett Asuncion
David Matta

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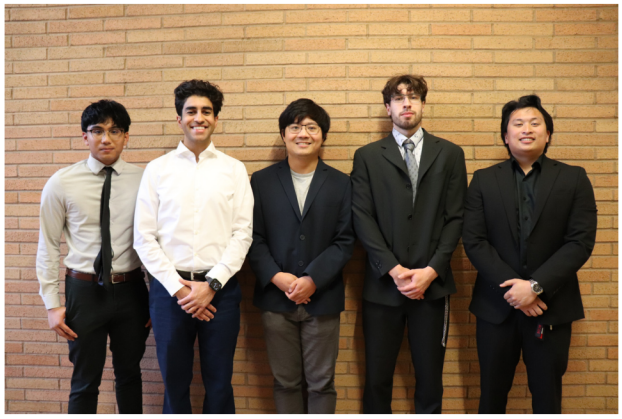
CONDUCTOBOND: DESIGN OF A SUTURELESS CONDUCTIVE ADHESIVE FOR TEMPORARY EPICARDIAL PACING

Temporary epicardial pacing sutures risk tissue damage, infection, and complications like loosening or difficult removal due to a beating heart's forces. While synthesized biomaterials offer potential solutions, limitations persist: hydrogels swell excessively and lack elasticity; elastomers have inconsistent conductivity and poor cytocompatibility; metal additives risk overheating and lack biocompatibility. To address these issues, our team developed a novel conductive interface material combining the benefits of these approaches. Using poly(glycerol sebacate acrylate) (PGSA) functionalized with choline-based ionic liquids (BILs), we achieved a material that is cytocompatible, biodegradable, and adheres well short-term, while maintaining elasticity, conductivity, and structural stability—offering a safer, more effective alternative to sutures.



TEAM

Cindy Akkari
Hadis Jowkar
Mia Siong
Stella Zaragoza

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HAND-TRACKING SURGICAL LIGHTING SYSTEM

Bacterial contamination in operating rooms, particularly affecting up to 50% of surgical light handles, significantly increases the risk of hospital-acquired infections among surgical patients. Current lighting solutions, even when equipped with sterile covers, often compromise sterility due to frequent manual adjustments. To address this, our hand-tracking surgical lighting system employs hand-tracking technology and automated adjustments to minimize touchpoints, preserve sterility, and enhance overall usability.

TEAM

Ryan Johnson
Alyanna Almario
Justin Bustamante
Nil Sanli
Ashton Lian

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HYDROPATCH

Puncture wound injuries are commonly treated by a combination of disinfectants, bandages, stitches, and gauze. However, these methods are surface-level and do not provide a suitable extracellular matrix for enhancing cell proliferation or improving hemostatic effects. HydroPatch aims to treat deep-cut wounds through a three-dimensional wound dressing. It dispenses an antimicrobial hydrogel that provides an ideal environment for cell migration. Our hydrogel is embedded with Magnesium Oxide (MgO) nanoparticles (NPs), Hyaluronic Acid (HyA), and Gelatin crosslinked by Transglutaminase (Tg) to enhance mechanical and antimicrobial mechanisms. The device was heated using an exothermic reaction between $MgCl_2$ and H_2O to melt the gelatin at ~37°C to be mixed with the rest of the components.

TEAM

Tara Kia
Katie Lao
Connor Nieh
Joseph Nguyen
Samantha Tovar

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The Park Lab at

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INSTRUMENTATION FOR OCT-BASED MICROSCOPY

Visualizing 3D biological structures is crucial for studying tissue morphology and cellular processes. Traditional microscopy provides high resolution but is limited in depth, while MRI and ultrasound offer deeper imaging penetration at lower resolution. Optical coherence tomography (OCT) bridges this gap with micron-level resolution over a depth range of a few millimeters. Our project aims to develop an interface that integrates an OCT system into an Olympus upright microscope for simultaneous traditional and OCT imaging. Functional validation of the device demonstrates its ability to limit power loss, optimize optical functions, and provide co-registered, high-quality images. By enabling real-time, multimodal imaging within a single setup, our innovation enhances efficiency and accuracy in tissue analysis, offering a powerful tool for biomedical research.

TEAM

John Zhao
Andrew Nguyen
Olivia Chacon
Nalleli Sepulveda

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MURINE NEONATE NEC HOUSING UNIT

The Murine Neonate NEC Housing Unit is an automated system designed to improve research on necrotizing enterocolitis (NEC), a neonatal disease which can have a mortality rate as high as 50%. It addresses key limitations in current models by integrating three major components to simulate the pathophysiology of the disease: a cooling system for inducing hypothermia (36°C to 4°C), a nitrogen-based hypoxia chamber, and an automated feeding system that delivers consistent formula volumes to multiple pups over extended periods. The system maintains desired conditions over 20 hour time intervals, improving reproducibility while reducing manual labor. By reducing the chances of human error, this system supports better data collection and treatment development, while increasing efficiency in NEC research.

TEAM

Eileen Cota Islas
Rutva Doshi
Erick Garcia
Dhyan Patel
Ethan Walls

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NEUROSPIN: AN MRI ROTATING DEVICE

Functional magnetic resonance imaging (fMRI) plays a crucial role in diagnosing brain diseases related to blood flow. Arterial Spin Labeling (ASL), a perfusion imaging technique, measures cerebral blood flow by magnetically labeling water in arterial blood and detecting a signal difference between labeled and unlabeled blood. Accurate blood perfusion measurements require specific magnetic pulse sequences, each with varying SNR and contrast levels. To ensure safety and efficacy in preclinical testing, we propose a novel rotating phantom with an electric motor in the MRI room to improve ASL testing. This approach offers improved performance, cost-effectiveness, and consistency while adhering to safety standards, allowing for the development of more sophisticated imaging protocols.

TEAM

Melanie Barahona
Karthika Chidambaram
Marcus Huynh
Xiang Li
Nohemi Rodriguez Hernandez

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LOMA LINDA UNIVERSITY HEALTH

NICU NOISE SHIELD

Our device aims to effectively reduce harmful noise levels for preterm infants within an isolette which could improve physiological factors such as increased heart rate, blood pressure, respiratory rate, and reduced oxygen levels. Our Noise Shield implements Active Noise Cancellation (ANC) technology to detect and attenuate unwanted noise in real time while permitting essential noise such as human voices to be heard by the preterm infants.

TEAM

Fiona Dimaranan
Benjamin Glauner,
Tyler Ng
Chris Rauch
Ayden Tulpo

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The Kokkoni Lab at

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PEDIATRIC "SMART" HARNESS FOR MOTOR REHABILITATION

Body weight-supported (BWS) physical therapy devices offer a targeted approach to improving motor function for individuals with neuromuscular deficiencies. Current approaches to tracking rehabilitation progress are often qualitative and rely on subjective observation and patient feedback, resulting in insufficient monitoring due to the lack of quantitative data. Our modified pediatric BWS harness utilizes integrated wireless electromyograph (EMG), electrocardiograph (ECG) and inertial measurement unit (IMU) sensors to improve motor rehabilitation monitoring. Our design team focused on sensor integration and real-time, wireless data transmission using Raspberry Pi modules, enabling clinicians to perform gait analysis, personalize physical therapy sessions, and assess patient progress more effectively.

TEAM

Ameen Ahmed
Anthony Del Mundo
Chris Overton
Egor Sbytov
Elaina Yip

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R'AUDIO HAPTIC SOUND NAVIGATOR

Individuals with hearing impairments face challenges in localizing sound, especially alerts and sirens. This dilemma particularly concerns spatial awareness and safety. Tactile and non-auditory assistive technology is a more discreet approach specialized to enhance sound localization. Our project presents a wearable haptic feedback system able to capture real-time audio alerting users in its direction through haptic vibration motors attached to a belt. Two main components of the device are glasses and haptic belt. A total of 4 MEMS microphones are attached to the glasses for unobstructed sound input. The haptic belt will consist of Raspberry Pi, battery, and vibration motors in serial connection for haptic feedback. Python-based algorithms and functions manage the software responsible for filtering, calibration, and directionality.

TEAM

Christian Viloria
Dhruv Kanumury
Shaganjit Sandhu
Michael Weden
Wayne Niswander

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REACTIVE PNEUMATIC ANKLE ORTHOSIS

A reactive pneumatic ankle orthosis is an advanced assistive device designed to provide real-time adaptive support for individuals with ankle instability. Utilizing force-sensitive resistors (FSRs), the system detects pressure changes and dynamically inflates custom soft actuators via a compact air compressor, ensuring responsive and precise support. A MOSFET-controlled circuit optimizes actuation efficiency, while a lightweight, soft-brace design enhances user comfort, while battery powered operation allows for untethered mobility. This device offers a practical solution to rehabilitation and daily mobility support, integrating advanced pneumatic technology to improve stability and movement for users in clinical and everyday settings.

TEAM

Jacob Hensley
Anya Jobalia
Audrey Wojcik
Malia Freese
Jennifer Zheng

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The Morgan Lab at

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S.W.A.M.P.P

Cell culture studies are essential for biological research, yet current automated perfusion systems for mammalian cell culture are costly, complex, and prone to contamination. Our group has developed a magnetically-actuated pump that fits within a standard six-well plate, creating a controlled microenvironment that preserves sterility and facilitates media exchange through a microfluidic device. The pump system comprises 3D-printed impellers attached to permanent neodymium-iron-boron (NdFeB) magnets and utilizes a rotating magnetic field to drive fluid motion. This device minimizes contamination risks by being self-contained and improving workflow efficiency, making it a practical and cost-effective solution for microfluidic cell culture applications.

TEAM

Evelyn Aguirre Vargas
Hannah Suderman
Vivienne Lee
My Linh Le
Olivia Chau

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2023-2024 VOCalyze team

VOCALYZE: VOLATILE ORGANIC COMPOUND SENSING IN BREAST MILK

With more than 300,000 infants admitted to NICUs annually, 49% of admissions are infants less than 37 weeks gestation, healthcare providers need to ensure the breast milk they feed patients is of high quality. Our project aims to aid medical technicians in the quality assurance of breast milk by designing a device, VOCalyze, that can measure multiple milk samples to detect spoilage bacteria. VOCalyze uses volatile organic compound (VOC) sensors to detect released gases from bacterial growth and gives out data in quantitative VOC concentration graphs and qualitative Spoiled/Not Spoiled readings. Our device contains a set of ethanol and ammonia sensors in individualized chambers to capture real-time milk spoilage profiles, providing convenient and reliable results to the user.

TEAM

Austin Wong
Anthony Tran
Ethan Bernabe
Moises Ortega
Shreya Agarwal

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WEARABLE PANIC ATTACK DETECTION DEVICE

Panic disorders affect about 20% of adults and 30% of adolescents in the U.S., with panic attacks significantly impacting daily life. While current wearables track stress, they lack real-time panic attack prediction. Our team developed a wearable bracelet that uses biometric sensors and AI to detect and predict panic attacks. It continuously monitors heart rate variability (HRV), interbeat interval (IBI), blood volume pulse (BVP), and movement to distinguish panic symptoms from regular activity. AI trained on clinical and user data personalizes detection for greater accuracy. When a panic attack is detected, haptic feedback provides a calming physical cue. The device also syncs with a mobile app for real-time alerts and vitals tracking. Unlike existing tools, our device emphasizes proactive prediction over reactive care.

TEAM

Shiva Annamaneni
Carl Hong
Mandy Hsieh
Joshua Kuo
Bryan Vadhin

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The Vullev Lab at

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WINE INSPIRED SOLAR ENERGY (W. I. S. E.)

The W.I.S.E team is developing an efficient p-type dye-sensitized solar cell (p-DSSC) using bio-inspired pyranoflavylium dyes derived from red wine pigments. These dyes serve as photo-oxidizing agents, facilitating hole injection into semiconductors upon sunlight exposure. The introduction of carboxylate anchoring groups enhances these dyes' attachment to oxide semiconductors, improving stability. The structural integrity and purity of these dyes are validated through NMR spectroscopy and mass spectrometry, while electrochemical and optical measurements evaluate charge transfer efficiency. This project aims to improve photocathode performance as well as addressing p-DSSC limitations for use as energy sources in smaller medical devices. Successful implementation could enhance solar-driven chemical conversions, expanding DSSCs' role in renewable energy applications.

MATERIALS SCIENCE & ENGINEERING TWO-QUARTER COURSE SERIES

Dmytro V. Zagrebelnyy
Assistant Professor of Teaching
MSE Undergraduate Faculty Advisor
Materials Science and Engineering
Program Department

MSE175A/B is a two-quarter (23 weeks) sequence focused on exercising students' abilities to design solutions in the field of Materials Science and Engineering. The course covers key aspects of design, such as identification of need, definition of problem, synthesis, optimization and presentation. Common industry techniques and approaches, including brainstorming, 5Why, FMEA, project management, budgeting, quality assurance, SOPs, and engineering reports are covered as well.

MSE 175A/B

WINTER (PLANNING)

Background Research
Proposal Writing
Engineering Economics/Budgeting
Project Management & DOE

SPRING (EXECUTION)

Standardization
Experimentation/Validation
Quality Control
Engineering Reports
Economic and other outcomes

MATERIALS SCIENCE & ENGINEERING SPONSORS

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TEAM

Jason Zeeb
Alexander Maldonado
Julian Rodriguez

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The Bartels Lab at

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CREATING AND TESTING VERTICAL TRANSITION METAL DICHALCOGENIDE DEVICES VIA SUBSTRATE BACK-ETCHING

Our project aims to develop faster, more efficient semiconductor devices for high-frequency applications such as satellite and radio communication. We are using advanced materials, such as transition metal dichalcogenides (TMDs), which have excellent electrical properties when combined with silicon substrates with gallium nitride (GaN) and aluminum nitride (AlN). To improve device performance, we must remove the silicon beneath the device without causing damage. We've developed a cost-effective acid etching method to selectively remove this silicon layer. This process is more affordable than current plasma etching techniques and could make it easier to fabricate high-speed diodes. Our work may help create a more consistent, scalable method for producing these cutting-edge devices, contributing to advancing next-generation electronics and communication technologies.

TEAM

Vinesh Manian
Jase Ushiro
Daniel Gonzalez-Ibarra

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HOWMET AEROSPACE

GRAIN EVOLUTION OF NICKEL-BASED SUPERALLOYS FROM HEAT SOAKING

Heat soaking is a process that is used to heat parts and maintain their temperature in between forging processes. This involves heating the material to a specified temperature for a specified amount of time. The purpose of this project is to investigate the impact of time, temperature, and forging processes on the grain growth of Rene 41 and GTD 222 during the heat soaking process.

TEAM

Ricardo Barcenas
Karan Patel
Daniel Zau

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The Bartels Lab at

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HEATING STAGE FOR MOLECULAR BEAM EPITAXY CHAMBER

Transition Metal Dichalcogenides (TMDs) are a unique 2D semiconducting material with promising commercial and research applications compared to traditional semiconductors due to their high carrier mobility and versatility for use in both electronics and optoelectronics. Molecular Beam Epitaxy (MBE) is a common method of growth for these materials because of their ability to grow thin, single crystal structures with minimal defects. For this to occur, the substrate must maintain a certain temperature to allow atoms to propagate across the surface of the sample. The goal of this project is to develop a heating stage capable of bringing the growth substrate to an optimal temperature of 750–850 °C, ensuring single layer growth is achieved and consistently maintained throughout the process.

TEAM

Jiahe Chen
Kasey Coser

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The Cui Lab at

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LOCAL ANODIC OXIDATION (LAO) OF GRAPHENE FOR MOIRÉ SUPERLATTICE NANOMATERIAL EXPERIMENTATION, VIA ATOMIC FORCE MICROSCOPE (AFM)

This University of California, Riverside (UCR) Materials Science & Engineering (MSE) Senior Design project will investigate the use of local anodic oxidation (LAO) via atomic force microscope (AFM). The specific purpose is to fabricate nanoscale stencils that will later be used by our project mentor (PM) for researching experimental 2D nanomaterials. The stencils that will be produced will be composed of graphene, and they shall enable precise modification of 2D nanomaterials that have atomic structures which can be described as Moiré superlattices. We aim to develop a repeatable procedure that results in high-resolution features in the graphene stencils.

TEAM

Lonnie Calhoun
Jiale Chen
Thomas Hamilton

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Superior HANDFORGE

THE EFFECT OF RAMP RATE ON TWO STEP AGE IN 7XXX SERIES ALUMINUM ALLOY

Our goal is to investigate the effect of ramp rate during a multi-step aging process on the tensile strength of 7050 aluminum alloy, which is vital for aerospace and high-performance applications. The process includes furnace calibration, controlled heat treatment at various ramp rates, tensile testing, and SEM analysis to assess microstructural changes. It aims to optimize processing efficiency and mechanical performance by identifying ideal ramp rate conditions that improve strength while reducing production time. Sponsored by Superior Handforge, the research is aimed to enhance the heat treatment process, which will potentially reduce energy consumption and production times for aluminum alloys used in lightweight, high-strength applications.

MECHANICAL ENGINEERING TWO-QUARTER COURSE SERIES

James P. Sawyer
Lecturer
Mechanical Engineering

Farbod Khoshnoud
Lecturer
Mechanical Engineering

The goal of the ME175B/C two-quarter course sequence is to develop the student's ability to generate, evaluate and present solutions to open-ended engineering design problems that have multiple realistic constraints. In completing the ME175B/C course sequence, students will learn the design process, design methodologies, and skills for working in team environments. The team project focus emphasizes the design process, which includes problem definition, conceptual design, modeling and analysis, embodiment and detail design, and design verification and validation through physical and/or virtual prototyping.

ME 175B/C

QUARTER 1

Team Formation
Background Research
Problem Definition
Concept Generation and Selection
Embodimet Design
Modeling and Analysis

QUARTER 2

Detail Design
Prototyping
Design Evaluation

TEAM

Rupin Nagireddy
Kathy Rodriguez
Jules Virrey

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AUTOMATED PROTECTIVE WINDOW SHUTTERS FOR SEVERE STORM CONDITIONS

In locations such as the Midwestern and Southern United States, severe storms provide conditions to greatly damage residential buildings and cause loss of life to its residents. Windows are critical weak points of these structures and destruction of these could lead to catastrophic structural failure. In addition, traditional storm shutters are often manually placed onto windows, taking time that is crucial for securing one's home and belongings. The goal of this project is to design a storm shutter system to automatically deploy onto residential windows, offering occupant egress and electrical redundancy in the case of power loss.

TEAM

Albert Dela Rose
Brandon Tabata
Esmeralda Merida
Patrick Fong

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BEVBOT: A ROBOTIC SOLUTION TO HOMEMADE DRINKS

Many individuals and families face challenges in preparing homemade beverages due to limited time, energy, and culinary expertise. With many consumers having less than 30 minutes available for meal or drink preparation, they often resort to prepackaged drinks, takeout, or forgo making beverages altogether. BevBot addresses this gap by automating the creation of custom mixed drinks in a typical home kitchen. Using a 6-degree-of-freedom robotic arm and precision dispensing mechanisms, BevBot streamlines the drink-making process to deliver consistent, high-quality beverages with minimal effort. Furthermore, this project lays the groundwork for future advances in automated food preparation.

TEAM

Tyler Rawlings
Alejandro Feliciano
Lidia C. Cordova Quero
Fardad Haratian

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CANINE KENNEL HYDRATION SYSTEM

The Canine Kennel Hydration System is a fully automated solution designed for shelters and kennels to reliably provide clean drinking water to up to 20 dogs. The system operates without municipal power or water for up to one week, delivering one gallon of water per dog per day. It includes an insulated reservoir, a gravity-fed distribution system, and tamper-resistant dispensers. Designed to withstand temperatures from 15°F to 110°F, it maintains water between 40°F and 90°F. By minimizing labor and reducing contamination risks, the hydration system improves animal health and emergency readiness in understaffed facilities.

TEAM

Ulises Monroy
Elijah Perez
Daniel Ocampo
Nogwa Smith

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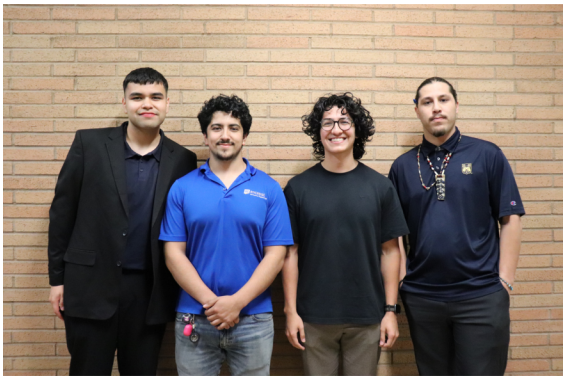
DESIGN OF A CLOSED-LOOP ENERGY HARVESTING SEMI-ACTIVE SUSPENSION SYSTEM

This project aims to develop a self-sufficient system that enhances ride comfort by harnessing excess vibrational energy and utilizing it to dampen unwanted movements. Using a quarter-car model to simulate suspension behavior across diverse road surfaces, the core challenge lies in optimizing the trade-off between energy harvesting effectiveness and the power requirements of the semi-active suspension components.



TEAM

Andrew Garcia
Jennifer Truong
Joshua Ramirez
Oscar Gil

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hex homes

DESIGN OF A SYSTEM THAT ACCURATELY SIZES AN EFFICIENT HVAC SYSTEM FOR AN INTERCHANGEABLE, SUSTAINABLE, NET-ZERO HOUSING UNIT.

This project utilizes a developed floor plan from Hex Homes to perform HVAC load calculations based on Manual J standards. Using this floor plan, we will conduct a SolidWorks Flow Simulation to visualize airflow and heat transfer within the space. The results will inform the development of a MATLAB-based application designed to act as a deliverable for HexHomes or similar companies. This tool will enable users to input custom floor plans and receive accurate HVAC sizing estimates. Initially tailored to a single pod design, the application will also feature options to add or modify pods, aligning with Manual J fundamentals. This modular and user-friendly calculator will support energy-efficient design and scalability in modern residential construction.

TEAM

Jimmy Gao
Cristofer Son
Leah Martinez
Nicholas Jap

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VTOL FIXED WING TRICOPTER

The Fixed Wing Tri-copter our team developed aims to provide a solution to situations where vertical take-off and landing vehicles are needed. Using Solidworks 3D modeling, structural analysis, and flow analysis, we developed a vehicle that is capable of vertically taking off and landing without a runway but maintaining the same efficiency as a traditional fixed wing aircraft.

TEAM

Mustafa Said
Brian Altamirano
Christopher Jimenez
Ulisses Zepeda

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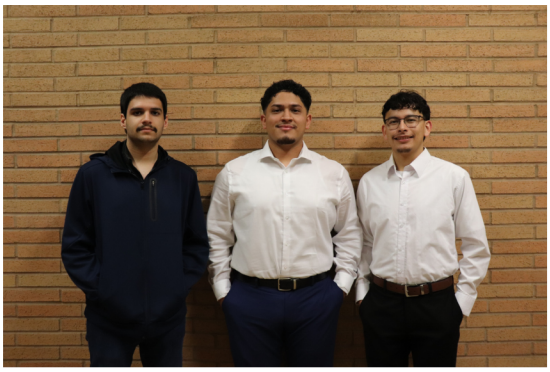
LONG RANGE AUTONOMOUS UAV

This project is aimed to develop a self sustaining UAV optimized for wildfire prevention and surveillance. The UAV will fly autonomously, detect and report potential fire/fire threats, reducing the financial cost and health risks of traditional firefighting, by integrating sensing, extended flight endurance, and autonomous flight.



TEAM

Jonathan Yelenich
Alaa Mohamed Taha
Nicolas Leigh
Adrian Lau

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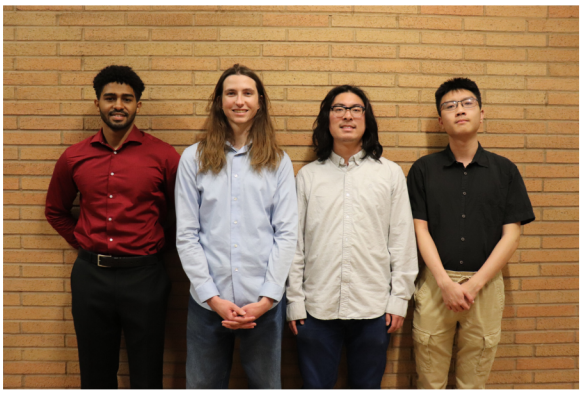
MARINE ENERGY HARVESTING

Our team has developed a marine energy harvesting system using a fixed, vertical-axis H-type Darrieus turbine to power offshore research facilities in remote environments. The turbine's symmetrical airfoil blades efficiently capture energy from multidirectional ocean currents, supported by a generator, gearbox, and spherical roller bearings. Our system aims to achieve optimal tip speed ratio of 1.3 and an initial efficiency of 23.5%. Designed for durability and low environmental impact, this system delivers up to 26 kW of sustainable power to support autonomous ocean research.



TEAM

Soham Saha
Luciano Bermudez

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LOCKHEED MARTIN

MULTI-AGENT MOBILE ROBOTS WITH QUANTUM (LASER) COMMUNICATION

This project introduces a precision alignment system for quantum-secure communication between mobile robots using laser-based Vehicle-to-Vehicle (V2V) links. ArUco markers and OpenCV were used for pose estimation and real-time tracking, controlled through a PID feedback system. Coarse alignment was achieved via servo-driven pan-tilt motion, while fine adjustments used Fast Steering Mirrors and Position Sensing Detectors. The system supports robust tracking and is adaptable for Quantum Key Distribution (QKD) protocols like BB84. A live demonstration confirmed system functionality. Future work involves integrating single-photon sources, mobile robot mounting, and dual pan-tilt communication setups. This platform addresses key challenges in alignment and security, forming a scalable foundation for quantum-enhanced communication in autonomous and multi-agent robotic systems.

TEAM

Emily Chung
Omar Dennawi
Vihan Jagasia
Ben Yu

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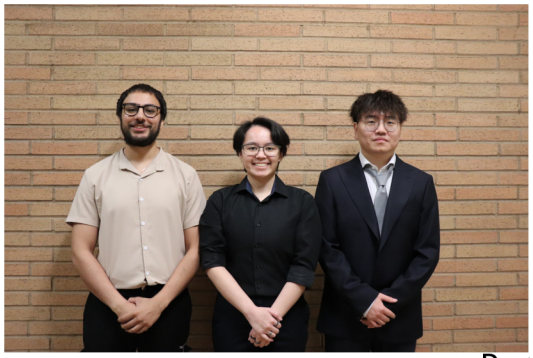
LOCKHEED MARTIN

MULTI-AGENT MOBLIE ROBOTS WITH QUANTUM (LASER) COMMUNICATION

The goal of this project is to create a system for two Multi-Agent Robots that use Quantum Cryptography (laser communication) and padded encryption. A sender robot will have a pan-and-tilt motion tracking camera, photon emitters for coarse alignment and fine alignment, and a long-pass dichroic mirror to allow a signal laser to pass through while an alignment laser deflects and superimposes with the signal beam. A receiver robot will have a pan-and tilt system, and a high pass dichroic mirror to allow the alignment laser to pass through onto a photo-sensitive detector and the signal beam to reach the polarizing beam splitter for decryption.



TEAM

Fernando Bermudez
Eric Vo
Yuxin Qin
Justin Kim

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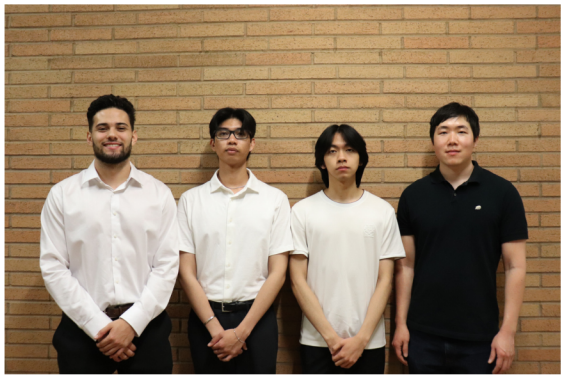
SELF REPLICATING MODULAR ROBOTS

Self-replicating-modular robots are individual robots which can move and autonomously replicate itself by using individual assemblies to act as a whole.These robots have a wide variety of applications from the space to manufacturing industries by providing fully autonomous, scalable, and adaptable solutions. The applications of self-replicating modular robots will be discussed along with potential design requirements, quantitative specifications, and components that address the design problem.



TEAM

Bryan Chen
Preth Paul
Matthew Munoz
Nicolas Ballesteros

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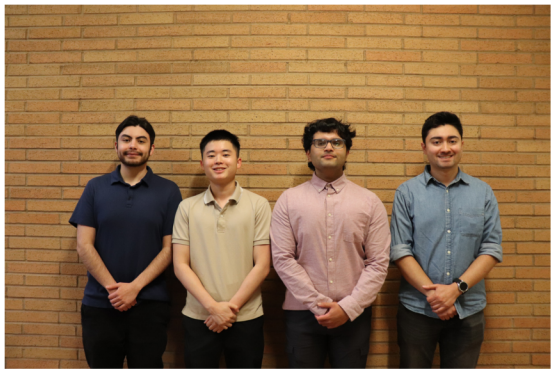
SOLAR FUEL CELL VEHICLE TESTBED

The SFCV-2 project involves the design and development of a solar fuel cell vehicle prototype that serves as a testbed for evaluating system dynamics, examining characteristic energy curves, and inducing basic locomotion. The goal is to study how solar and fuel cell technologies interact in a small-scale vehicle platform, with real-time data acquisition used to monitor performance and efficiency. This setup provides a controlled environment to test energy management strategies and explore the practical challenges of integrating renewable energy sources in transportation systems.



TEAM

Alexandria Marie Melendres
Raymond Tran
Skyllure Hang
Alex Wu

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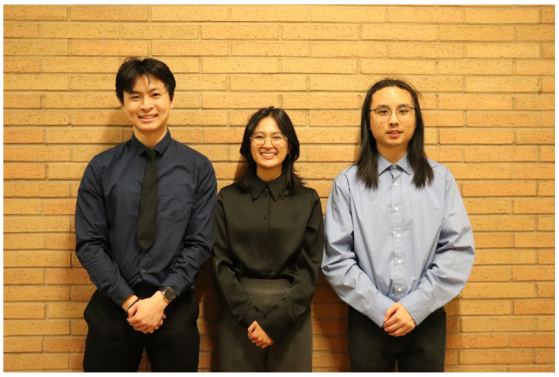
SSR-2 SHAPE SHIFTING ROBOT

The SSR-2 project is an autonomous, shape-shifting robot that transitions between two physical states to assist nurses amid the growing shortage while being compact. By handling cleaning and storage tasks, nurses can focus on patient care and critical responsibilities. Designed for affordability, ease of use, and open-source accessibility, the robot enhances efficiency in fast-paced hospital environments. Competing with other medical innovations, it offers a practical solution to support healthcare workers while adapting to their demanding workflow.



TEAM

Alex Pham
Oliver Behrens
Adam Tsugawa

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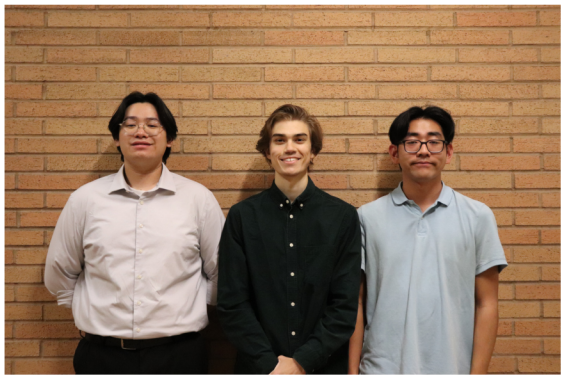
VARIABLE PITCH PROPELLER FOR MULTIROTOR DRONES

The project of VPP-1 is to create a cyclic pitch controlled multirotor drone that can perform at the same effectiveness as a common fixed pitch drone. Using mechanisms inspired by traditional single rotor aircraft (a helicopter for example), the proposed prototype will be able to create moments of rotation through the variable pitch of each propeller. The design solution for this project is to create a foundational testing setup that will demonstrate vertical balance using the variable pitch propellor system on two axes of rotation (pitch and yaw) and the ability to control altitude.



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