

Mechanical Engineering
Newsletter SPRING 2024

MOMENTUM

ENGINEERED FOR
WHAT'S NEXT.



Cullen College of Engineering
UNIVERSITY OF HOUSTON

Letter from the Chair



Dear Colleagues,

Greetings! I hope you are well. I am delighted to share some of the highlights and accomplishments of the UH Mechanical Engineering department's esteemed faculty and industrious students. There are many exciting developments in progress in our department, and I invite you to come visit us in person when you can. When we collaborate, we have the potential to make great strides in innovation.

Warm Regards,

Karolos Grigoriadis, Ph.D.

Interim Department Chair of Mechanical Engineering
Director of Aerospace Engineering
Cullen College of Engineering
University of Houston

UH ME **BY THE NUMBERS**



FACULTY (FALL 2022)

- 4** NATIONAL ACADEMY OF ENGINEERING MEMBERS
- 2** NATIONAL ACADEMY OF INVENTORS FELLOWS
- 1** NATIONAL ACADEMY OF INVENTORS SENIOR MEMBER



ENROLLMENT (FALL 2023)

1060 UNDERGRADUATE STUDENTS

268 GRADUATE STUDENTS



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DEGREES AWARDED
(FY 2022)



184 B.S.



53 M.S.



31 PH.D.

NATIONAL RECOGNITION

MARZIA CESCON

WINNER OF THE



2024
FACULTY EARLY CAREER
DEVELOPMENT (CAREER)
AWARD



FROM THE NATIONAL SCIENCE FOUNDATION



MECHANICAL ENGINEERING



For **Marzia Cescon**, the David C. Zimmerman Assistant Professor of Mechanical Engineering, the news that she had earned funding for her National Science Foundation (NSF) CAREER proposal came as a welcome surprise.

Cescon's proposal is "Data-Enabled Neural Multi-Step Predictive Control (DeMuSPc): a Learning-Based Predictive and Adaptive Control Approach for Complex Nonlinear Systems." The award amount is \$655,248.

She described her field of expertise as automatic control – technology that controls processes in order to achieve desired behaviors.

"We observe, and with the tools that we develop, we mathematically describe various phenomena occurring in nature and in our environment, and we use this knowledge to act upon and control these phenomena," she said. "Automatic control is ubiquitous in our homes, cars and infrastructure. It is the quintessential multidisciplinary field, addressing seemingly unrelated problems with a unified theory."

As examples of practical applications of this knowledge, Cescon pointed to the autopilot function of a Boeing 747, which follows a predetermined trajectory while adjusting to wind and currents. A biological form of automatic control is in the human body, such as temperature control based on workload or light control by a retina.

Cescon's interest in automatic control started while earning her B.Sc. in Information Engineering from the University of Padova in Italy.

Cescon earned her M.Sc. in Automation Engineering from Padova, followed by her doctorate in Automatic Control from Lund University in Sweden. She credited her advisors there, along with support from her peers at UH and the hard work of her students, as direct reasons for her current success.

The CAREER award runs through August 2029. For more information on Cescon's research, visit her group's website. ⚙️



Pictured: Ben Xu

UH RESEARCHER PART OF **\$5 MILLION DOD GRANT TO SUPPORT DEFENSE MANUFACTURING**

The U.S. Department of Defense (DoD) awarded a \$5 million grant to the University of Texas Rio Grande Valley (UTRGV)-led America's Additive Foundry Consortium, which includes the University of Houston as a key partner.

Ben Xu, assistant professor of mechanical engineering and Presidential Frontier Faculty Fellow at UH, will serve as the site director of the Houston-based Demonstration Hub for the consortium. The demonstration hub will link small and medium-sized manufacturers to DoD contractors, showcase various advanced manufacturing processes, provide local technical support to facilitate commercialization and implementation of the proposed novel technologies and help upskill and reskill existing workforce.

"Securing the supply of specialty alloys and maintaining the ability to conduct forging and casting operations are essential to producing military equipment," Xu said. "We [the consortium] will develop and demonstrate alternative casting and forging processes by leveraging metal additive/hybrid/convergent manufacturing technologies to modernize America's foundry operations in the Texas Coastal Plains region through advanced research, technical support, business development, and workforce training with a focus on small manufacturers."

The consortium has an ambitious agenda. During the five-year grant period, the consortium aims to demonstrate additive casting and hybrid forging processes to 1,800 manufacturers, incubate 45 startups and pitch 30 companies. In addition, it will leverage resources of partner institutions to provide relevant workforce training and educational programs. ⚙️



Pictured: Kelly Huang

UH MECHANICAL ENGINEERING **WELCOMES NEW FACULTY MEMBER IN SPRING 2024**

Kelly Huang joined the University of Houston Cullen College of Engineering as an Assistant Professor in the mechanical engineering department in Spring 2024. Huang's research focuses on investigations of the turbulent processes that drive the atmospheric surface layer and the development of novel and high-resolution sensing techniques.

Prior to arriving at UH, Huang completed a postdoctoral appointment at the University of Notre Dame and received her PhD in Mechanical and Aerospace Engineering at Princeton University. During her PhD, she received the NDSEG Fellowship and the Engineering Council's Excellence in Teaching Award. ⚙️

JOURNAL PUBLICATION

Charge/Discharge

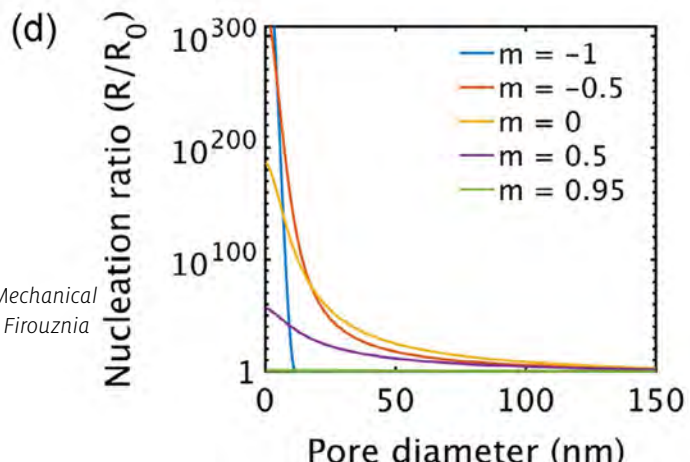
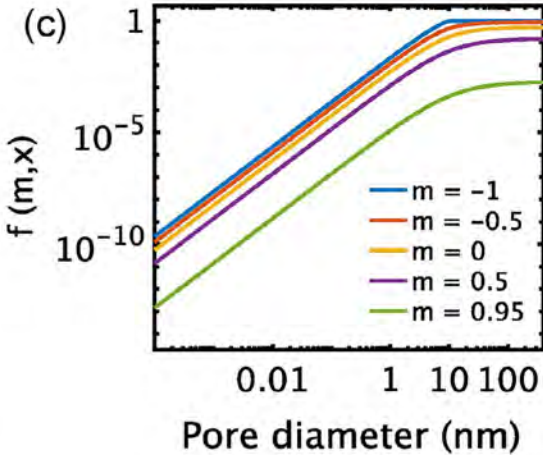
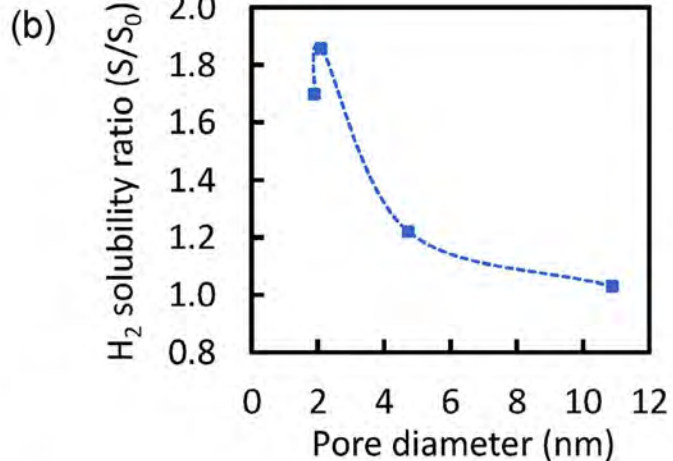


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Pictured: Recent research from UH Mechanical Engineering doctoral student, Rojan Firouznia featured in Materials Today Physics.

MECHANICAL ENGINEERING



UH MECH STUDENT'S HIGH CAPACITY HYDROGEN RESEARCH FEATURED IN MATERIALS JOURNAL



A paper from a University of Houston mechanical doctoral student, **Rojan Firuznia** who is part of the research group of Hadi Ghasemi Associate Professor of Mechanical Engineering, was featured in Materials Today Physics late last year.

“High-capacity hydrogen storage through molecularly restructured and confined hydrogen hydrates” showcases the advanced efforts in the areas of energy storage.

Listed authors for the research include **Rojan Firuznia**, Amir Abutalib, Alireza Hakimian, Sina Nazifi, Zixu Huang, T. Randall Lee, **Jeffrey D. Rimer**, **Hadi Ghasemi**.

Ghasemi identified Firuznia as doing strong work on this paper. She expects to complete her doctorate in Fall 2025. She is excited to be furthering her research efforts and continuing in her research role. ⚙️

Science Advances

***Pictured:** New research from Tian Chen featured on the cover of Science Advances could lead to the creation of material architecture that changes its behavior based on different temperature situations.*



UH RESEARCHER PICKED FOR **SCIENCE ADVANCES JOURNAL COVER**

New research by a professor in the Mechanical Engineering Department of the Cullen College of Engineering could lead to the creation of material architecture that changes its behavior based on different temperature situations.

Tian “Tim” Chen, Kamel Salama Endowed Assistant Professor of Mechanical Engineering, is the lead author for “Algorithmic encoding of adaptive responses in temperature-sensing multimaterial architectures.” The article was chosen for a November cover in Science Advances.

Chen noted that when designing systems, engineers have to keep a set of functionalities in mind that account for the material’s properties. However, their research goal was to design systems that react intelligently, using internal microstructure with hardware and software integration.

This work constitutes one critical step towards achieving programmable matter, which are artificial materials whose characteristics, mechanical or otherwise, are programmable in the way that computer programs are programmable

Chen joined the faculty in September 2021 and runs the Architected Intelligent Matter (A.I.M.) Lab, which has its own website. Earlier this year, a video with him and Steve Mould, an author and educational presenter, reached 1.5 million views in less than a week. That video now has close to 5 million views. ⚙️

UH RESEARCHERS DEVELOP NEW PERCUSSION METHOD TO **DETECT PIPELINE ELBOW EROSION**



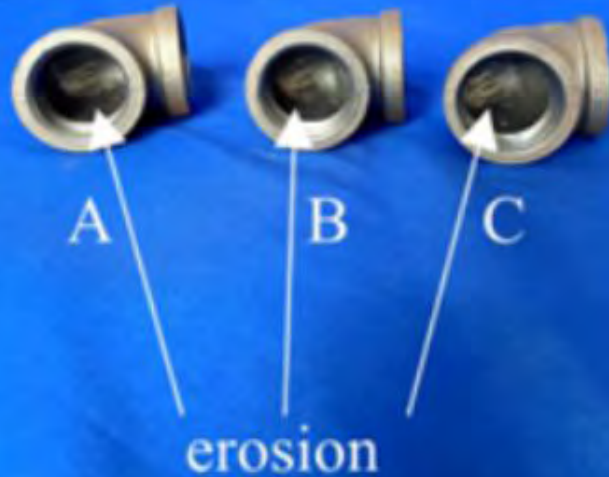
A University of Houston engineering research team is pioneering a new method, based on percussion, to detect pipeline elbow erosion. It is no small problem.

Below the surface of the earth, a veritable superhighway of piping carries corrosive liquids and transports elements like carbon dioxide, hydrogen, methanol and others for a variety of industrial needs from oil well cementing to chemical min-

ing. And at each turn, a pipeline elbow is affixed to shepherd the flow in new directions. Research reveals that due to erosion, the mass loss of the pipeline elbow is around 50 times larger than that of the straight pipe and the wall thickness of the pipeline elbow becomes thinner through continuous operation. This may lead to bursting or piercing of the pipeline elbow, resulting in economic losses, environmental pollution and other safety issues.

“We propose a novel detection method for pipeline elbow erosion, combining percussion, variational mode decomposition (VMD) and deep learning,” reports **Gangbing Song**, Moores Professor of Mechanical Engineering, in the journal *Mechanical Systems and Signal Processing*. “The new method removes the need for the constant-contact sensor and professional operator and shows great applicability in different pipeline elbows with the same structure and dimension and is easy-to-implement, low-cost, and free of the installation of a constant-contact-sensor.” ⚙️

Pictured: Since the 90-degree pipeline elbows are prone to erosion, detection of pipeline elbow erosion is critical to the health of pipeline systems.



Pictured: Yash Kulkarni



ME'S YASH KULKARNI NAMED PRESIDENT OF THE SOCIETY OF ENGINEERING SCIENCES

Yashashree Kulkarni, the Bill D. Cook Professor of Mechanical Engineering at the Cullen College of Engineering, will serve as the president of the Society of Engineering Science (SES) in 2024. SES dates back to 1963, when it was founded as a non-profit organization, dedicated to the advancement of interdisciplinary research at the interface of engineering and science. Today, it is a vibrant society with close to 1,000 members. Two major annual activities of the SES board include hosting an annual conference that brings together people from different disciplines of engineering sciences and recognizing the accomplishments of members of the engineering science community through awards.

"It is indeed an honor to serve my scientific community as the president of SES. The SES has made enormous strides over the past decades, and along with an illustrious team of board members, I am excited to further increase its impact through different initiatives," Kulkarni said.

One of the first announcements she made as the president was the establishment of a new mid-career award named after a woman scientist. "The SES Emmy Noether medal celebrates women in engineering and recognizes Noether's fundamental contributions to the development of conservation laws which are foundational to the field of engineering sciences," she said.

Kulkarni joined the UH faculty in 2009. She earned her Ph.D. and M.S. in Applied Mechanics from the California Institute of Technology, and her Bachelor's degree from the Indian Institute of Technology in Bombay.

In addition to serving on the SES board, Kulkarni serves as an associate editor for two flagship journals for the American Society of Mechanical Engineers in the field of mechanics – Applied Mechanics Reviews and Journal of Applied Mechanics. She became an ASME Fellow in 2022 and recently received \$675,000 from a pair of National Science Foundation awards for her interdisciplinary and collaborative research investigating the role of mechanics in materials science and biology. ⚙️



ME'S ZHAO EARNS NATIONAL SCIENCE FOUNDATION FUNDING FOR **KIRCHHOFF'S LAW, SOLAR RESEARCH**

Bo Zhao, assistant professor in the Mechanical Engineering Department at the Cullen College of Engineering, has earned funding from the National Science Foundation for a pair of research proposals in the past year. In February, his proposal "Nonreciprocal Photonic Devices for Solar Thermophotovoltaics" was selected for \$50,000 in funding. The research is part of the NSF's Innovation Corps (I-Corps) program, which is a seven week "immersive, entrepreneurial training program that facilitates the transformation of invention to impact."

According to the project's abstract, "The development of a nonreciprocal photonic solution for solar energy harvesting systems. Compared to traditional solar cells, this proposed technology enables continuous electricity production in a cost-effective manner, operates around the clock, demonstrates compactness, scalability, and portability, and, most importantly, exhibits significantly higher efficiency compared to traditional solar photovoltaic systems. In addition, the portable nature of this technology makes it particularly suitable for deployment in underdeveloped regions and areas where establishing conventional power plants is challenging." Zhao also received \$351,337 in June for his proposal, "Thermal Emission beyond the Conventional Kirchhoff's Law."

According to the research abstract, "Despite the great benefits of nonreciprocal thermal emitters in solar energy, heat rectification and circulation, the understanding of nonreciprocal thermal radiation is lacking. This project aims to demonstrate a new theory valid for all thermal emitters, including nonreciprocal ones. We refer to this theory as the generalized Kirchhoff's law."

Zhao joined the Cullen College of Engineering in Fall 2021, after working as a postdoctoral research associate at Stanford University. He earned his Ph.D. from Georgia Institute of Technology in 2016. Currently, he serves as the director of the Thermal PhotonX (TPX) Lab at UH, where his research group focuses on the theoretical and experimental aspects of thermal photonic transport processes. Their work aims to advance thermal management, energy conversion and information processing. ⚙️



UH MECHANICAL DOCTORAL STUDENT PART OF
INAUGURAL COHORT **OF UH CHEVRON
ENERGY GRADUATE FELLOWS**



University of Houston, the Energy University, is proud to introduce the inaugural cohort of UH-Chevron Energy Graduate Fellows – eight graduate students who are actively involved in innovative energy-related research across the UH campus. Funded by Chevron, the program supports graduate students' research efforts through a one-year, \$12,000 fellowship which includes mentoring by faculty experts and the opportunity to engage with subject matter experts at Chevron.

Chirag Goel is a Ph.D. student in materials science and engineering at UH, working under Professor Venkat Selvamannickam's mentorship since 2021. His research focuses on thin film fabrication of long-length high-temperature superconductors using Advanced MOCVD or metal organic chemical vapor deposition. Goel earned his master's in mechanical engineering from UH in 2020. From 2020 to 2021, he worked as a researcher in Selvamannickam's Energy and Device Fabrication Lab. He has co-authored seven published reference papers in renowned journals such as Superconductor Science and Technology and IEEE Transactions on Applied Superconductivity. Goel hopes to work on groundbreaking advancements in materials science and energy technologies. ⚙️

CULLEN

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The University of Houston

Cullen College of Engineering

The University of Houston Cullen College of Engineering addresses key challenges in energy, healthcare, infrastructure, and the environment by conducting cutting-edge research and graduating hundreds of world-class engineers each year. With research expenditures topping \$40 million and increasing each year, we continue to follow our tradition of excellence in spearheading research that has a real, direct impact in the Houston region and beyond.

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