Updated 27/02/2025

2025 UQ Winter Research Project Description

Project Title:	**Engineering design support for UQ's X2 expansion tube hypersonic impulse wind tunnel**
Project Duration:	36 hours per week for 4 weeks on-site.
Positions Available:	1
Description:	UQ's X2 expansion tube is a hypersonics impulse wind tunnel used for the simulation planetary entry and high-speed flight from 3 to 20 km/s. Like any machine, it is a mechanical system which is sometimes in need of upgrades to ensure it maintains peak performance. This project's goal is to design and perform some small mechanical upgrades on the facility to make it more reliable and easier to operate. This includes a new design for the internals of the capstans which separate different parts of X2's driven tubes to ensure that they do not come loose as often and upgrades to some other small parts of the X2 facility as needed.
Expected Outcomes and Deliverables:	This project will give students the chance to be a part of a large interconnected laboratory group focused on the study of the phenomena related to planetary entry and high-speed flight and contribute to improving experimentation in that laboratory. While this project is not a research project directly, it will give the student the ability to experience this type of research environment. The student will gain skills in the full engineering design process from scoping the design and then working with our staff, students and technicians to procure, manufacture and install experimental hardware. The project's outcome will be a report detailing the design of these upgrades and hopefully manufactured components in use on the facility.
Suitable for:	As engineering design experience is required for this project, it is open to Mechanical and Mechanical and Aerospace students in their 3rd and 4th years. Due to the short project duration, students with some actual engineering design experience would be preferred but is not essential.
Supervisor:	Dr Chris James
Further info:	Please email Chris at c.james4@uq.edu.au if you would like further information related to this project.

Project Title:	**In silico exploration of particle transport in complex microfluidic flows**
Project Duration:	This project will run for 36 hours per week over four weeks. The successful applicant will work within the Computational Multiphysics Laboratory (CML) in the School of Mechanical and Mining Engineering at UQ's St Lucia campus.
Positions Available:	1
Description:	The CML has developed computational models that can predict the behaviour of complex particle suspensions during the production of oil and gas from reservoirs which are deep underground (and impossible to observe directly). This work has recently uncovered some fundamental new insights on the behaviour of particle suspensions, including how they self-organise and coalesce under different operating conditions. These findings have direct implications for technologies related to the human bloodstream, including the intravenous delivery of pharmaceuticals and the sorting of cancerous cells in microfluidic devices. However, there is more that is yet to be understood (e.g. how partial reversal of flow, such as that driven by the cardiac cycle, changes these behaviours). The aim of this project is to develop advanced computational models of coupled fluid-particle systems and apply them to investigate the influence of particle shape and channel tortuosity on migration, segregation, and clogging in oscillatory flow. This will be conducted using the open-source simulation developed within the CML, which employs the lattice Boltzmann method for fluid mechanics and the discrete element method for particle mechanics.
Expected Outcomes and Deliverables:	In completing this project, the successful applicant will develop skills in: • The rheology and mechanics of particle suspension; • The lattice Boltzmann method for fluid mechanics; • The discrete element method for granular materials; • Parallel computing using multi-GPU hardware and clusters; • Linux operating systems. The outcomes from this work are to be delivered via presentations to the regular CML meetings and a final report, which is to be crafted in the form of a scientific manuscript.
Suitable for:	This project is open to students with a background in mechanical engineering and an interest in computational fluid dynamics. The successful applicant will have completed at least three years of their degree.
Supervisor:	A/Prof Christopher Leonardi
Further info:	Please email Chris at c.leonardi@uq.edu.au if you would like further information related to this project.

Project Title:	**Sodium ion batteries for grid connect storage**
Project Duration:	Students will be engaged for 4 weeks only. Hours of engagement must be between 20 – 36 hrs per week. As this work will be based in the laboratory, this will be predominately on-site project. Data analysis can be completed remotely.
Positions Available:	1
Description:	Sodium-ion batteries (NIBs) hold a great promise for scalable energy storage applications due to the natural abundance of sodium resources. However, one of the grand challenges for the NIB technology is the low energy density. To improve energy density, an anode free battery is being developing. In this system sodium is directly deposited on the current collector. To improve this deposition process, the current collector can be modified through nanoengineering or coatings. In this project, the student will explore sodium metal deposition for sodium metal batteries using in operando electron microscopy. This project will involve development and characterisation of coating modifications, so it would be best that the either student has laboratory experience or be interested in work in a laboratory.
Expected Outcomes and Deliverables:	The student will develop a fundamental insight into how batteries work, which would help understanding other electrochemical energy systems and larger-scale batteries. In addition, the student will develop laboratory and data analysis skills to correlated battery performance with material characteristics.
Suitable for:	This project is open to applications from 3rd or 4th year students with a background or interest in materials science and engineering.
Supervisor:	A/Prof Ruth Knibbe
Further info:	Please email Ruth at ruth.knibbe@uq.edu.au if you would like further information related to this project.

Project Title:	**Understanding Electrode Morphology in CO_2 Electrolysers Using Volume Imaging**
Project Duration:	Students will be engaged for 4 weeks only. Hours of engagement must be between 20 – 36 hrs per week. As this work will be based in the laboratory, this will be predominately on-site project. Data analysis can be completed remotely.
Positions Available:	1
Description:	Electrochemical CO_2 reduction (CO_2RR) is a promising pathway for converting CO_2 into valuable fuels and chemicals. However, the performance and durability of CO_2 electrolysers are strongly influenced by electrode morphology, which governs mass transport, local reaction environments, and catalyst stability. A key challenge in optimising these systems is the ability to visualize and understand electrode structure at different stages of operation. In this project, the student will develop advanced volume imaging methods to investigate electrode morphology in CO_2 electrolysers. The focus will be on designing and applying imaging techniques—such as electron tomography or X-ray computed tomography—to track structural evolution during operation. This project involves experimental method development, electrode characterization, and data analysis. Experience and interest in research and interest in image processing and reconstruction is beneficial.
Expected Outcomes and Deliverables:	The student will gain fundamental insights into how CO_2 electrolysers operate, providing a deeper understanding of electrochemical energy systems and their broader applications. Additionally, the student will develop data analysis skills to correlate electrode morphology with electrolyser performance. This includes expertise in advanced imaging techniques and data interpretation, which are valuable for careers in energy storage and conversion research.
Suitable for:	This project is open to applications from 3rd or 4th year students with a background or interest in materials science and engineering and image processing.
Supervisor:	A/Prof Ruth Knibbe
Further info:	Please email Ruth at ruth.knibbe@uq.edu.au if you would like further information related to this project.

Project Title:	**Developing an autonomous driving platform**
Project Duration:	4 weeks at 36 hrs/week, 30th June – 25th July, at St Lucia campus
Positions Available:	2
Description:	This project seeks to continue development of Errol the autonomous Lexus. Errol is equipped with drive-by-wire capability and has an array of sensors suitable for informing autonomous driving decisions. We aim to: 1. Collect and publish datasets that further development in situational awareness (localisation, object detection). 2. Implement autonomous valet parking capability in the Autoware.auto software stack. 3. Produce a plant model of the vehicle, relating its inputs (throttle/break/steering/gear) to its outputs (speed, heading, position). Then develop a steering/speed controller to regulate.
Expected Outcomes and Deliverables:	Development of a real autonomous vehicle. Improving skillsets in hardware configuration, software interactions, and the managing the middleware between them. Exposure to managing and working with a sensor suite intended for the automation of a mobile platform. Working in and contributing to an existing codebase.
Suitable for:	Mechatronic students 3rd/4th/5th year. Comfortable in programming (C++), Linux OS, and programming interfaces (ROS2) are preferred but reasonably learnable on the job.
Supervisor:	Dr Tyson Phillips
Further info:	Please email Tyson at t.phillips1@uq.edu.au if you would like further information related to this project.