Updated 09/09/2024

2025 UQ Summer Research Project Description

Project Title:	Design, build and testing of scaled model urban and rural environments in UQ's low-speed wind tunnel
Project Duration:	28 hours per week for 6 weeks, offered on-site
Positions Available:	2
Description:	The shape and arrangement of buildings and trees in rural and urban environments alter the wind flow pattern and affect their response to weather extremes. Wind tunnels can be used for modelling and investigating the airflow pattern in urban and rural environments to provide an understanding of these effects. In this project, students will design scaled models of urban and rural settings for testing at UQ's low-speed wind tunnel. After manufacturing the models, they will set it up in the wind tunnel and use flow visualisation to compare wind patterns around different environments.
Expected Outcomes and Deliverables:	This project will give the students the opportunity to gain practical experience in design and testing of experimental research. It is expected that by the end of the project, the students have designed and manufactured models and conducted some preliminary testing in the wind tunnel.
Suitable for:	The project is open to Mechanical and Mechanical and Aerospace students in their 3rd and 4th years.
Supervisor:	Dr Azadeh Jafari (a.jafari@uq.edu.au)
Further info:	Please email me if you're interested in the project to have a chat.

Project Title:	Engineering design support for UQ's X2 expansion tube hypersonic impulse wind tunnel
Project Duration:	36 hours per week for 6 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 the design of a mount for a hydraulic ram to push and pull the facility's driver tube back and forward during facility changeover between experiments and 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.
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. Students with some actual engineering design experience would be preferred, but is not essential.
Supervisor:	Dr Chris James (c.james4@uq.edu.au)
Further info:	If you're interested in my project, please email me to discuss further, before submitting an application.

Project Title:	In silico exploration of particle transport in complex microfluidic flows
Project Duration:	This project will run for 36 hours per week over six 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:	Investigating factors that affect particle focusing performance in viscoelastic fluids-based microfluidic devices
Project Duration:	6 weeks, 30 hrs per week. The project will be offered through a hybrid arrangement, while the experiments will be performed on-site, data and image analysis can be performed remotely.
Positions Available:	1
Description:	Particle/cell focusing is very important and essential for sorting, counting, detecting, and analysis in a wide range of fields, including disease diagnostics, biological and chemical analysis, food processing, and environmental assessment. Compared with conventional techniques, microfluidic techniques have emerged as efficient and powerful alternatives for particle/cell manipulation (e.g., particle focusing, separation, etc.) due to their unique advantages of lower cost with higher efficiency and accuracy. However, most of the existing microfluidic methods are based on Newtonian fluids, large knowledge gaps exist, particularly in the area of non-Newtonian fluids (e.g., viscoelastic fluids). In fact, viscoelastic fluids such as blood, saliva, cytoplasm, and most of other body fluids, are very ubiquitous in our daily life and in real world issues. Therefore, it is important to investigate particle focusing and migration in viscoelastic fluids to develop a deep understanding of particle/cell behaviours in these fluids. The aim of this project is to systematically study and explore the influence of various factors such as the polymer type (PEO, HA, Starch, SiO2), polymer concentration, channel size and structure, flow rates, and particle size on the particle focusing performance to inform us how to achieve a better particle focusing performance using viscoelastic microfluidics. It is expected that the outcome will enhance our understanding of particle migration in viscoelastic fluids and improve our ability of microfluidic particle focusing to meet the growing demand for the manipulation of particles as advances in cell biology, environment, biomedicine, etc.
Expected Outcomes and Deliverables:	Scholars will specifically focus on two polymer type including Starch, SiO2, which can form shear-thickening viscoelastic fluids and new particle migration phenomenon. Based on this, the influencing factors of polymer concentration, particle size, flow rates on particle migration will be further studied. From the project, scholars can gain skills in device design and fabrication, experimental tests, and image and data analysis. They will have an opportunity to generate publications from their research. They may also be asked to produce a report or oral presentation at the end of their project.
Suitable for:	This project is open to applications from students with a background in mechanical/biomedical/chemical/electrical. 3rd – 4th year undergraduate students and Masters students only.
Supervisor:	Dr. Dan Yuan (d.yuan@uq.edu.au)
Further info:	If you are interested, please send your CV and transcripts to Dr Dan Yuan (d.yuan@uq.edu.au) and discuss further details on project specifics.

Project Title:	Ceramic coated polymer models for hypersonic ground testing
Project Duration:	20-36 hours per week for 6 weeks, offered on-site
Positions Available:	1
Description:	The application for this topic is magnetohydrodynamic (MHD) aerobraking, whereby it is proposed that a strong magnet be used to control the hot plasma flowing past a spacecraft during atmospheric entry, in order to increase vehicle drag and reduce surface heating. UQ is currently performing experimental research to simulate this technology in its hypersonic ground test wind tunnel facilities. A key requirement of this future technology is that the forebody of the wind tunnel spacecraft model is electrically insulated, but that it can also survive the intense but impulsive pressure and heat loads which occur during the expansion tube wind tunnel experiments. Test times in these facilities are around 1 millisecond max; while this may seem like a short duration, surface heating is of the order 10-100MW/m^2, pressure loads are of the order of 1MPa, and the model is also subject to hypervelocity impacts from particulates entrained in the test flow (due to the way these wind tunnels work). In future experiments we plan to use polymer model forebodies to ensure electrical insulation, with ceramic or other high temperature coatings to prevent ablation of the plastic during the actual test time. The forebody must have its thickness minimised in order to ensure that the magnetic field generated from within the model spacecraft remains strong at the model external surface. A recent ENGG4601 honours thesis study into ceramic-coated polymer models identified two coating concepts that could potentially meet the demanding experimental requirements: 1. Application of a thin layer of ceramic adhesive to act as a thermal protective coating for polymer models. 2. Fabrication of a thicker protective shell using castable ceramics. While these products were not tested as part of that thesis, the products have been procured and are ready for testing. The aim of this project is to extend the earlier honours thesis work by now fabricating coated and cast samples and conducting a detailed evaluation of the two candidate techniques. The project will involve reviewing the previous work and proposed fabrication procedures, updating the procedures as required, fabricating a range of coated specimens, and evaluating the results. The casting concept, which will involve casting castable ceramic directly onto the nylon forebody, is likely to require some iterations to establish effective hardware and procedures; in turn, this will require the candidate student to apply CAD design and additive manufacturing skills to modify and optimise the experimental setup and geometry of the nylon/polymer substrate.
Expected Outcomes and Deliverables:	The student is expected to design a specimen fabrication test matrix, prepare the specimens, evaluate them, and prepare a report summarising the results. It is expected that some degree of model redesign and fabrication will be required. The student will develop their skills in experimentation, laboratory skills, CAD design, additive manufacturing, and WHS.
Suitable for:	This project is open to applications from mechanical engineering students who have successfully complete their 3rd year courses. The project requires a student with: an interest in hypersonic ground testing; strong laboratory skills; strong appreciation of safe work practices; and CAD and manufacturing skills to enable evaluation of several generations of prototype.

Supervisor:	David Gildfind (d.gildfind@uq.edu.au)
Further info:	For further information, please email d.gildfind@uq.edu.au

Project Title:	Biocompatible Alloys
Project Duration:	Hours of engagement will be between 20 – 36 hrs per week.
Positions Available:	1
Description:	A range of new metallic materials will be evaluated for applications in medical implants
Expected Outcomes and Deliverables:	Scholars will gain skills in literature review preparation, manufacturing methods, corrosion and in-vitro testing.
Suitable for:	Suits a student with Biotechnology background
Supervisor:	Prof Matthew Dargusch (m.dargusch@uq.edu.au)
Further info:	For further information, please email m.dargusch@uq.edu.au

Project Title:	Manufacturing and testing functional composite antenna structures for uncrewed aerial systems
Project Duration:	36 hrs per week for 6 weeks on-site
Positions Available:	1
Description:	Functional composite materials are advanced materials used for both their structural performance and additional functions. This project focuses on functional composite antenna structures, where a composite structure also acts as a radio communications antenna. This is advantageous in aerospace applications where external antennas are not practical due to drag, or in applications where moving antennas into a load-bearing part of the structure provides improved radio performance through better line-of-sight. This project is part of a larger program of work in the UQ Composites group to develop novel antennas that integrate into structural components of uncrewed aerial systems (UAS). The program will develop prototype antennas that demonstrate the potential for this technology to extend the range of aerospace platforms and provide our industry partners with a capability edge over competitors. The main motivation behind this summer research project is to support manufacturing and testing activities while giving a student engineer exposure to functional composites. This project aims to manufacture and test antennas integrated into composite laminate structures. Manufacturing these structures requires integration of conductive radiating antenna elements and electrical feed networks into a conventional composite laminate manufacturing process. The developed manufacturing methodologies must ensure these components are of correct dimensions and position to ensure good electrical performance. The developed testing methodologies should aim to confirm that the antenna maintains its performance even when the structure is under stress induced by aerodynamic loads. The project aims for these developments to be used for an application with an industry partner. The student will have the opportunity to contribute to other aspects of development including design work and modelling and simulation work. The work will be highly collaborative within a team of UQ researchers, government research scientists, engineers from our industry partners, and BE/ME placement students.
Expected Outcomes and Deliverables:	The student researcher will have the opportunity to learn about conventional composite manufacturing as well as functional composite manufacturing. It is expected that the student will spend some time fabricating components in the UQ Innovate makerspace including using computer-aided manufacturing techniques, such as developing toolpaths for CNC machines from CAD models. The work will also include composite layup in the UQ Composites labs. All necessary training will be provided for these hands-on activities. The main outcomes of the project will be fabricated prototype parts, mechanical testing data to accompany these that confirms structural integrity and performance, and a brief report outlining your methodology and results.
Suitable for:	This project is suitable for any engineering student interested in learning more about aerospace structures, composite materials, prototype design and manufacturing, functional materials or smart structures.

	The only necessary skills are a basic understanding of CAD and engineering mechanics, i.e. stress and strain. Experience with hands-on manufacturing or prototyping, such as taking things apart or building things (even for a hobby) will be highly beneficial.
Supervisor:	Dr Mitch Dunn (m.dunn1@uq.edu.au)
Further info:	If you are interested in this project, please contact Mitch Dunn (m.dunn1@uq.edu.au) before applying to have a quick chat about what you would like to get out of the project. You are also welcome to arrange a time to visit the lab and see more about the project in person.

Project Title:	Investigation of Railway Studs and Squats
Project Duration:	20-36 hours per week for 6 weeks, offered on-site
Positions Available:	1
Description:	The research seeks to develop a generalised validated mathematical model for rail studs, and in particular to examine how this mechanism differs from that for rail squats. Railway studs and squats are track defects that grow via dynamic loading over successive train wheel passages. Modelling would be used to predict growth of studs and to evaluate and determine optimum railway vehicle and track conditions to mitigate this rail defect. The aim of this project to contribute a literature review and structure/initial attempt of a multiphyisics model to predict when squats and studs can initiate based on extreme tractional/heating and stress conditions.
Expected Outcomes and Deliverables:	The researcher will gain skills in literature review and mathematical modelling of a multi-physics phenomenon. Students will be asked to produce a short report (and informal presentation) at the end of their project.
Suitable for:	Students in their last or second last year of study with background in dynamics, heat transfer or fatigue.
Supervisor:	Professor Paul Meehan (meehan@uq.edu.au)
Further info:	For further information please contact Paul Meehan (meehan@uq.edu.au)

Project Title:	Design of the Gear-Rack driving system for Chain-die forming process
Project Duration:	36 hours per week for 6 weeks, offered on-site
Positions Available:	1
Description:	The Chain-die forming technology is a patented innovative advance manufacturing technology which is able to produce critical steel parts for many industries such as solar rails and door beams for cars. Currently, the contact between the driving gear and rack on the tool blocks are experiencing periodic movements due to imperfect contour. To optimise the forming process, the goal of the project is to redesign the gear and rack geometry to ensure the smooth transition of the driving power, reduce the concentrated contact stress, improve the wear performance and improve the stability and robustness of the forming machine. The design will be validated through finite element simulation
Expected Outcomes and Deliverables:	Applicants may gain skills in engineering design and finite element simulation for cold sheet metal forming process. The project will give the students a chance to be part of the advanced manufacturing group, experience the research environment and potentially contributing to research publications. The project's outcome will be a report detailing the design of the components and simulation results demonstrating the improvements achieved.
Suitable for:	This project is open to applications from students with a background in Mechanical engineering, 2nd last to final year students only. The project will involve in the design of components for industrial grade machine, actual engineering design experience would be preferred, but is not essential.
Supervisor:	Professor Paul Meehan (meehan@uq.edu.au)
Further info:	For further information please contact Paul Meehan (meehan@uq.edu.au)

Project Title:	Investigation of Squeal/Flutter Phenomena
Project Duration:	20-36 hours per week for 6 weeks, offered on-site
Positions Available:	1
Description:	Squeal is a tonal noise (in the hearing range of 1-10kHz) from a frictionally excited unstable mode of vibration that results from the slowing of a vehicle with disk brakes (brake squeal) or cornering of a train (wheel squeal). Its occurrence is often identified as 'fugitive', and unpredictable, ie a 'squealing' brake does not squeal during all braking events. Mode coupling also occurs in aeroelastic structures and causes flutter. There have been many theories formulated to understand the phenomenon of squeal including the main mechanisms of; falling friction, sprag-slip and modal coupling (or 'Binary flutter') but the merits and applicability are keenly debated. Similar research is being undergone with flutter in wind turbines. To address this, the UQ nonlinear mechanics team recently published the closed form identification, quantification and mitigation of squeal and flutter occurrence and amplitude under all mechanisms, for the first time. This unique insight has inspired the development of two unique experimental testrigs to validate the modelling predictions. This project aims to obtain and analyse the testrig experimental and/or CFD data to achieve this.
Expected Outcomes and Deliverables:	A validation between mathematical predictions and experimental measurements of squeal and/or flutter.
Suitable for:	4th or 5th year Mechanical or Mech/Aero/Mechatronics Engineering student. Strong ability and interest in dynamics.
Supervisor:	Professor Paul Meehan (meehan@uq.edu.au)
Further info:	For further information please contact Paul Meehan (meehan@uq.edu.au)

Project Title:	Sodium ion batteries for grid connect storage
Project Duration:	20 – 36 hrs per week for 6 weeks. 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 (ruth.knibbe@uq.edu.au)
Further info:	If you would like more information about the summer research project, please email me.

Project Title:	T4 Shock Tunnel Experiments and Analysis
Project Duration:	36 hrs per week for 6 weeks. Project offered primarily on-site. Opportunities to work remotely/at-home for 1-2 days each week as appropriate, to be discussed with supervisor.
Positions Available:	3
Description:	The T4 Shock Tunnel is a world-leading hypersonic facility, producing test flows that match flight conditions in temperature, pressure and velocity between Mach 5 – Mach 10. A primary component of the tunnel is the primary diaphragm, which bursts under high pressures to produce a high speed shock wave (hence the name of the tunnel). Experimental models are tested in T4, including fuelled models for testing combustion, and heated models for boundary layer transition experiments. A number of projects are available through this scheme, including: 1. Looking at changing tunnel test conditions through scoring primary diaphragms; 2. Aiding current experiments through heat transfer data gathering, calibration and analysis; 3. Analytical or numerical examination of simple combustion experiments to burn fuels efficiently. Students will be able to work both independently and as part of the T4 research teams on active T4 projects up to the discretion of the supervisor and the student.
Expected Outcomes and Deliverables:	Students will gain practical skills in experimental development, instrumentation, data collection and analysis. Depending on the project there may be a significant numerical/analytical component, which will help develop the students' programming and analytical skills. Students will conclude the project with a structured report to summarise their findings. The supervisors would encourage motivated students to publish high-quality research output to an international journal.
Suitable for:	These projects are available to 3rd – 4th year students. It is preferred the students will have a background in most of the following: • Mechanical engineering design • Fluid mechanics • Thermodynamics We are looking for highly motivated students to are interested in getting a feel for working in a hypersonics laboratory.
Supervisor:	A/Prof Anand Veeraragavan (primary supervisor)
Further info:	If you are interested in these projects, please contact Dr Tristan Vanyai by email on t.vanyai@uq.edu.au. Please send Dr Vanyai a brief cover letter and your CV prior to applying for this project. The supervisors may wish to conduct a short interview prior to the application deadline.

Project Title:	Simulating Magnetic Nano Particles in Hypersonic Flows
Project Duration:	36 hrs per week for 6 weeks. Project will be offered on-site, can be hybrid in later weeks.
Positions Available:	1
Description:	Scramjets, or supersonic combustion ramjets, are an air-breathing propulsion system capable of generating thrust at hypersonic speeds. Two challenges for scramjet efficiency are: the extremely short residence time in the combustor, during which fuel must be injected, mixed and burned; and the difficulty in having fuel jets penetrate form the wall to the centre of the combustor, which is essential for utilizing the available air. This project will computationally investigate a novel approach for addressing both challenges: Utilizing magnetic fields to manipulate fuel containing nanoparticles coated by a ferromagnetic material in a supersonic cross flow. The potential of a magnetic field to both pull the nanoparticles across the flow to increase penetration, and to slow the nanoparticles relative to the flow to increase residence time will be investigated. This project will utilise UQ's Eilmer multi-physics simulation code to study the problem. Successfully executing the project will require deriving and implementing a custom body force on the particle to model the effect of an applied magnetic field. Appropriate magnetic nanoparticle properties and magnetic field configuration will be investigated. Eilmer simulations using a deforming mesh can then be set up to simulate small portions on the nanoparticle motion to understand the influence of the field in the presence of a supersonic cross flow.
Expected Outcomes and Deliverables:	The successful scholar will gain skills computational model development and implementation, hypersonic flow simulation and data analysis. They will have an opportunity to generate publications from their research. The key deliverable is a final report at the end of the project.
Suitable for:	This project is open to applications from students who have completed 2nd year computational engineering, 3rd year computational mechanics and 3rd year fluid mechanics. You should have a strong interest and aptitude for numerical methods.
Supervisor:	Prof Vincent Wheatley (v.wheatley@uq.edu.au)
Further info:	For further information please contact v.wheatley@uq.edu.au Shortlisted applicants will be contacted to discuss the project prior to the scholarship being awarded.