Updated 31/08/23

2023-2024 UQ Summer Research Project Description

Project Title:	Design of global optimiser for designing new X2 expansion tube driver conditions.
Project Duration:	36 hours a week; on-site for 6 weeks.
Positions Available:	1
Dscription:	UQ's X2 expansion tube is an impulse wind tunnel used for the study of planetary entry and other types of hypersonic flight. It is powered by a "free piston driver" where compressed air is used to accelerate a piston in the facility's driver tube which compresses helium or helium and argon to high pressures and temperatures, which then acts as the driving gas for the experiment. X2 has a suite of nine current free piston driver conditions which work very well, but do not cover the whole potential performance envelope of the facility. Designing new driver conditions can be a laborious process because there are many design variables involved: piston mass, driver initial fill pressure, driver initial fill composition, primary diaphragm rupture pressure, reservoir pressure, and buffer length. This means that many solutions to achieving the same effective driver condition may exist and how to reduce the problem down is not obvious. To constrain the problem, often some of these variables are fixed in advance based on intuition to constrain what is otherwise too large of a design space. However, the risk of doing this is that "local maxima" in the design space may be found and optimised for, but which are not the actual "global maxima"of the whole design space. New counter-intuitive solutions may exist. The goal of this project is hook up current fast-running (of the order of seconds) free piston driver modelling codes used at UQ to a global optimiser in the hope that this will facilitate much more rapid design of new X2 driver conditions and ensure that the conditions which are designed are the best possible ones available.
Expected Outcomes and Deliverables:	Applicants will learn a lot about how impulse wind tunnels and their drivers work and how impulse wind tunnels are used to study planetary entry and other hypersonic flows. They will learn about how we model these facilities and about how to use optimisers to find global maxima in otherwise daunting design situations. The student will work in a laboratory with smart and motivated PhD students and staff giving them the ability to learn a lot from these people and build up contacts for their future careers.

	The final project deliverable will be the optimiser code itself and a report about how it works. Hopefully, some new driver conditions will be able to be designed using the code, and potentially tested in the facility in the future.
Suitable for:	3rd or 4th year mechanical and aerospace engineering students or students with similar skill sets. This is principally a coding and analysis project so programming and engineering analysis knowledge is needed from courses such as MECH2700 and MECH3750/MECH3780. Advanced courses like AERO4800 and MECH6480 are useful but not necessary. It is hoped that you would be competent and fairly independent with the use of Python related engineering analysis tools. Linux experience would be useful, but can be learnt on the job.
Supervisor:	Dr Chris James
Further info:	Feel free to email the project supervisor, Dr Chris James (c.james4@uq.edu.au) if you want further information.

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Project Title:	Towards highly-efficient computational fluid dynamics analysis of respiratory flow behaviour
Project Duration:	This position is offered as preferably on-site, but hybrid arrangements can be negotiated. The student will be asked to be engaged for the full 6 weeks of the summer program, preferably working 30-36 hours per week.
Positions Available:	1
Description:	The human upper airway (HUA) has been widely investigated in the literature to study the influence of e.g., geometrical parameters on the pressure, velocity, and flow regimes present. The high-fidelity information that can be supplied by advanced computational techniques has enhanced medical treatments and identified likely causes for obstruction. Clinically significant obstruction of the HUA can rapidly lead to asphyxia and death. Recently, our group has initiated a collaboration with researchers at RMIT with extensive experience in this space but facing computational challenges with existing software. This project looks to analyse the capability of our groups research code (TCLB, https://tclb.io/about/) to conduct high-fidelity simulations in the HUA and compare the accuracy of results along with computational performance with previously applied software.
Expected Outcomes and Deliverables:	The Research Scholar that participates in this program will gain skills in computational fluid dynamics, high-performance computing and numerical methods. The successful completion of this project will likely provide the student with the opportunity to generate a publication from their research. Students will be asked to produce a final presentation to translate their findings to the interested parties.
Suitable for:	This project is open to applications from students with a strong interest in numerical methods, fluid mechanics, and computational fluid dynamics. The project is open to students in their 3rd or later year of studies.
Supervisor:	Dr Travis Mitchell
Further info:	If applicants could contact Dr Travis Mitchell (t.mitchell@uq.edu.au) prior to applying that would be preferred.

Project Title:	Testing of Sustainable Alloys for Agricultural and Mining applications
Project Duration:	36 hours / week for 6-10 weeks. On-site attendance is required for the duration of the project.
Positions Available:	1
Description:	The project focuses on evaluating the abrasion and performance of ferrous alloys. Using lab equipment, the candidate will be conducting work towards evaluating the abrasion performance of cast alloys. With the help of group members, the candidate will be running lab tests and/or analysis and collecting results data. This will be followed by data analysis and interpretation. The project is a part of a large industrial project for one of our industry partners.
Expected Outcomes and Deliverables:	Scholars will gain hands-on experience is using hand tools, running laboratory experiments and data collection. They will be involved in specific tasks and have an opportunity to work on an industrially related project. Students may also be asked to produce a report at the end of their project.
Suitable for:	Students will need mechanical design skills and a knowledge of compressible gas dynamics.
Supervisor:	Dr Yahia Ali and Dr Jeff Gates
Further info:	For further information, please contact Dr Yahia Ali on y.ali@uq.edu.au

Project Title:	Investigation of Mechanisms and Controlling Factors in Edge-Fracture of Ceramic Elements in Macro-composite Wear Liners
Project Duration:	36 hours / week for 6-10 weeks. On-site attendance is required for the duration of the project.
Positions Available:	1
Description:	The project focuses on evaluating the fracture resistance of coarse-composite ceramic. Using a custom-built testing apparatus, the candidate will be evaluating the performance of different ceramic composite materials. With the help of group members, the candidate will be running lab tests and collecting weight loss data. This will be followed by data analysis and interpretation of the results. Evaluation of wear mechanisms and fractured surfaces may also be done as a part of the project.
Expected Outcomes and Deliverables:	Scholars will gain hands-on experience is using hand tools, running laboratory experiments and data collection. They will be involved in specific tasks and have an opportunity to work on an industrially related project. Students may also be asked to produce a report at the end of their project.
Suitable for:	This project is open to applications from students with a background in materials and/or mechanical engineering. Students must be commencing their thesis project in 2024. The project may include lifting of heavy parts (up to 20kg). The candidate is expected to have the ability to safely lift this weight.
Supervisor:	Dr Yahia Ali and Dr Ray Low
Further info:	For further information, please contact Dr Yahia Ali on y.ali@uq.edu.au

Project Title:	Investigating the Root Causes of Materials Failure – Chemistry Focused
Project Duration:	Hours of engagement must be between 20 – 36 hrs per week. Duration of the project 6-12 weeks. The project will be offered on-site.
Positions Available:	1
Description:	Assisting with completion of a variety of materials analysis and testing projects. Exposure to a holistic project management style including: initial client engagement, writing scopes and proposal, performing the analysis and assisting with the investigation and reporting, invoice and closing the project. Projects may include materials characterisation, failure analysis or performance. Techniques required (students will be exposed to some or all aspects of these and are not expected to have an in-depth knowledge only a willingness to learn) macroscopic analysis (photographic imaging and observations) stereomicroscopy and or polarised light observations and imaging. Additional techniques typically required include Fourier Transform Analysis, Scanning Electron Microscopy with BSE & EDS, X-Ray Diffraction, Thermogravimetric methods such as DSC &TGA.
Expected Outcomes and Deliverables:	Scholars will obtain an introduction knowledge of working in a professional multi-disciplinary team. Develop skills and have an opportunity to participate in the processes used to characterise materials and solve materials failure or performance problems. Learn how to prepare a professional report and exposure to the peer review process. Participation in the preparation and writing of scopes and proposals. Data entry into reports including macroscopic observations and recording and commenting on the outcomes of tests. Running instrumentation required for testing. Gathering information from various sources including standards, references, data sheets etc. Engage enthusiastically with a multidisciplinary team of scientist and engineers.
Suitable for:	This project is open to applications from students with a background in chemistry, Chemical or Materials Engineering. 3rd – 4th year students only.
Supervisor:	Dr Yahia Ali
Further info:	For further information, please contact Fiona Jones (f.jones@uqmp.uq.edu.au)

Project Title:	Investigation of Squeal/Flutter Phenomena
Project Duration:	6 weeks
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. To address this, the UQ nonlinear mechanics team recently published the closed form identification, quantification and mitigation of squeal occurrence and noise 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 experiment data to achieve this.
Expected Outcomes and Deliverables:	A validation between mathematical predictions and experimental measurements of squeal.
Suitable for:	4th or 5th year Mechanical or Mech/Aero/Mechatronics Engineering student. Strong ability and interest in dynamics.
Supervisor:	Prof Paul Meehan (meehan@uq.edu.au)
Further info:	For further information, please contact Prof Paul Meehan (meehan@uq.edu.au)