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M&M Post-Graduate Topics

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Mechanical & Mechatronic Engineering department
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Contents

Dr Nur Dhansay
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- **Research Field**
  Fracture Mechanics
- **General Description of Research Field**
  The investigation of cracks propagating through a material. The focus typically lies in providing crack prediction models for the various mechanisms of fracture. The general fracture mechanisms include fatigue, creep, stress corrosion cracking and environmentally induced cracking. A variety components in real world applications undergo loading application which produces the failure mechanisms mentioned previously. It is therefor of benefit to better understand these mechanisms in order to produce more accurate crack prediction models and prevent any unwanted failure/fracture in components.

Topics	**MEng Struct**	**MEng Resrch**	**PhD**	**Potential Funding**
Crack tip strain localisation investigation of hydrogen-induced fracture mechanisms for pipeline metals Considering the drive towards "green energy", it is believed that hydrogen will play a key role in transitioning from fossil fuels to renewable energy. Hydrogen gas requires transportation via pipeline. Unfortunately, metals are susceptible to hydrogen embrittlement (HE) which reduces the structural integrity of the material. Furthermore, the behaviour of HE metals tends to vary significantly, requiring special attention to be focussed on this topic. This research proposes to investigate the crack tip strain localisation of hydrogen-induced fracture mechanisms in pipeline steels using digital image correlation. **Requirements:** Ideally: Strength of Materials W334 Material Science A244		✓		

Dr Gareth Erfort
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- **Research Field**
  wind energy, CFD
- **General Description of Research Field**
  Open source CFD - extrnal aerodynamics Wind energy - resrouce assessment, small scale implementation, blade design and structural interactions

Topics	**MEng Struct**	**MEng Resrch**	**PhD**	**Potential Funding**
CFD modelling for wind resource measurements You need to model a large offshore body in CFD. This model will help decide on the placement for a met mast, to ensure minimal blockage effects from the base structure and nearby obstacles. Note this is not an Msc focused on computational fluid dynamics. CFD is just a tool for the project. The project explores wind measurement techniques, best practices as they line up with IEC 61400-12 and building knowledge for potential offshore studies in RSA **Requirements:** Wind energy background.	✓			
Techno-economic study of small wind turbines for City of cape town To assist in reducing the city's reliance on Eskom the student will investigate the range of small scale wind turbines in the market. The student will also make use of WASA 3 libraries to determine the wind conditions in and around the city. With the market survey complete the student will then have to site and model the distribution of small scale wind turbines. The output of the project is a proposed distributed wind plan for the city to increase their renewable energy implementation while keeping the costs as low as possible **Requirements:** wind energy course	✓			

Prof Jaap Hoffmann
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- **Research Field**
  Solar thermal energy
- **General Description of Research Field**
  Solar thermal energy is a source of clean energy for electricity generation, process heat and thermal comfort that is unfortunately only available while the sun is shining. Thermal energy storage in rock beds using air as heat transfer fluid provides a low cost solution to store energy harvested during the day for night-time use. The large size of rock bed thermal energy storage, and irregular nature of crushed rock particles means that much of previous research done on prismatic beds of spherical particles is inadequate to describe pressure drop and heat transfer through packed beds. Hydrogen fuel cells and electric vehicles are the most promising substitutes for petrol and diesel driven vehicles in a post fossil fuel work. Hydrogen vehicles offer ranges and refueling times like those achieved by internal combustion engines. Hydrogen is a form of chemical energy that can be stored indefinitely. On the downside, hydrogen infrastructure is lagging that of electricity distribution. Overall, the outlook for hydrogen as a replacement for petrol and diesel in the transport sector is positive provided that it can be produced competitively. The copper-chlorine cycle as the most promising of all the thermochemical cycles for hydrogen production. In this cycle, water (steam) first reacts with CuCl2 to form HCl, and the HCl is then split into H2 and CuCl in an electrolyzer. Splitting HCl requires only about a third of the electricity input of that of splitting H2O. To facilitate the chemical reactions and recycle chemicals, the cycle requires several heat inputs at different temperatures. Some reactions are exothermic, and the heat released can be internally recycled to reduce the overall heat requirement of the cycle.

Topics	**MEng Struct**	**MEng Resrch**	**PhD**	**Potential Funding**
Thermal management of a greenhouse in an arid environment Solar thermal energy is a clean alternative for fossil fuels in supplying heat to various industries. The downside is that energy is only available whilst the sun shines, and energy must be stored for continuous operation throughout the day. A system comprising of a packed bed of crushed rock using air as heat transfer fluid is one of the cheapest and most environmentally benign methods to store heat. Applications vary from (seasonal) temperature control in mines (heating in winter and cooling in summer), daily temperature control in greenhouses and buildings (cooling during the day and heating at night), heat for industrial process, and power generation to name a few. Designing a thermal energy system requires that engineers understand the various heat transfer processes happening simultaneously between the solid particles and the heat transfer fluid. Much work has been done for spherical particles in pebble bed nuclear reactors, but the is a lack of information on the heat transfer and pressure loss coefficients for irregular shaped particles. This research is aimed at determining these coefficients for rock beds. Access to this information will allow designers to find good cost/performance balance for rock bed thermal energy systems. In a hot and dry environment, it is imperative to minimize moisture loss, and keep temperatures down for optimum plant production. The greenhouse canopy is good at preventing moisture loss, but it increases the temperature inside the greenhouse. Shading, and using an earth heat exchanger to capture cool ambient air at night, and releasing it inside the greenhouse during the day can potentially lower the temperature inside the greenhouse. In winter, the earth heat exchanger can be used to capture warm air during the day for release in the greenhouse during the night. The objective of the study is to (a) model air flow in the greenhouse, (b) estimate the amount of shading that would reduce the heat load but won't affect photosynthesis significantly, and (c) size the earth heat exchanger for a particular application. **Requirements:** Students may find the following modules useful for their research: Advanced Fluid Mechanics, Advanced Heat Transfer, Numerical Fluid Dynamics and Solar Thermal Energy Systems.		✓		

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Particle convective heat transfer coefficient in a packed bed of crushed rock General description of research field: Solar thermal energy is a clean alternative for fossil fuels in supplying heat to various industries. The downside is that energy is only available whilst the sun shines, and energy must be stored for continuous operation throughout the day. A system comprising of a packed bed of crushed rock using air as heat transfer fluid is one of the cheapest and most environmentally benign methods to store heat. Applications vary from (seasonal) temperature control in mines (heating in winter and cooling in summer), daily temperature control in greenhouses and buildings (cooling during the day and heating at night), heat for industrial process, and power generation to name a few. Designing a thermal energy system requires that engineers understand the various heat transfer processes happening simultaneously between the solid particles and the heat transfer fluid. Much work has been done for spherical particles in pebble bed nuclear reactors, but the is a lack of information on the heat transfer and pressure loss coefficients for irregular shaped particles. This research is aimed at determining these coefficients for rock beds. Access to this information will allow designers to find good cost/performance balance for rock bed thermal energy systems. The objective of this project is to express the heat transfer coefficient in a packed bed as a function of: • particle Reynolds number, • a particle diameter and shape factor, • particle/flow alignment, and • packing density. The work can be either experimental, numerical (using a combination of discrete element modelling and computational fluid dynamics), or a blend of both. **Requirements:** Students may find the following modules useful for their research: Advanced Fluid Mechanics, Advanced Heat Transfer, Numerical Fluid Dynamics and Solar Thermal Energy Systems.		✓	✓	

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Conductive and radiative heat transfer in a packed bed of crushed rock Solar thermal energy is a clean alternative for fossil fuels in supplying heat to various industries. The downside is that energy is only available whilst the sun shines, and energy must be stored for continuous operation throughout the day. A system comprising of a packed bed of crushed rock using air as heat transfer fluid is one of the cheapest and most environmentally benign methods to store heat. Applications vary from (seasonal) temperature control in mines (heating in winter and cooling in summer), daily temperature control in greenhouses and buildings (cooling during the day and heating at night), heat for industrial process, and power generation to name a few. Designing a thermal energy system requires that engineers understand the various heat transfer processes happening simultaneously between the solid particles and the heat transfer fluid. Much work has been done for spherical particles in pebble bed nuclear reactors, but the is a lack of information on the heat transfer and pressure loss coefficients for irregular shaped particles. This research is aimed at determining these coefficients for rock beds. Access to this information will allow designers to find good cost/performance balance for rock bed thermal energy systems. When a packed bed is fully charged, the bed is idle and there is no flow and convection become negligible. Heat is transferred by conduction between neighbouring particles via conduction through particles, particle/particle contacts (contact resistance to be determined) and the surrounding air, as well as thermal radiation. The objective of this study is to develop models that deal with conduction and radiation in a packed bed, either separately or in combination. **Requirements:** Students may find the following modules useful for their research: Advanced Fluid Mechanics, Advanced Heat Transfer, Numerical Fluid Dynamics and Solar Thermal Energy Systems.		✓	✓	

Topics	**MEng Struct**	**MEng Resrch**	**PhD**	**Potential Funding**
Turbulence modelling in porous media Solar thermal energy is a clean alternative for fossil fuels in supplying heat to various industries. The downside is that energy is only available whilst the sun shines, and energy must be stored for continuous operation throughout the day. A system comprising of a packed bed of crushed rock using air as heat transfer fluid is one of the cheapest and most environmentally benign methods to store heat. Applications vary from (seasonal) temperature control in mines (heating in winter and cooling in summer), daily temperature control in greenhouses and buildings (cooling during the day and heating at night), heat for industrial process, and power generation to name a few. Designing a thermal energy system requires that engineers understand the various heat transfer processes happening simultaneously between the solid particles and the heat transfer fluid. Much work has been done for spherical particles in pebble bed nuclear reactors, but the is a lack of information on the heat transfer and pressure loss coefficients for irregular shaped particles. This research is aimed at determining these coefficients for rock beds. Access to this information will allow designers to find good cost/performance balance for rock bed thermal energy systems. Flow through porous media is tortuous, and the presence of the solid matric causes early transition to turbulent flow and additional turbulence production that is not present in flow through open channels. This turbulence helps to redistribute heat and momentum in a porous media. There are a few models in the literature to capture the extra turbulence production in the k-epsilon framework, but none (or few) for the k-omega turbulence models. Develop and validate (through the use of appropriate source terms) a model that can predict the extra turbulence dispersion in packed beds. Closure might be achieved on RANS, LES or DNS level. This project is expected to be mathematically intensive. **Requirements:** Advanced fluid mechanics and Numerical Fluid Dynamics 414/814 or equivalent would be advantageous.		✓	✓	

Prof Craig McGregor

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- **Research Field**
  Solar thermal energy, concentrating solar power (CSP)

- **General Description of Research Field**
  Solar thermal energy and concentrating solar power research is conducted through the ACWA Power Research Chair in CSP at Stellenbosch University. This collaboration provides unique access to operational data from commercial CSP facilities, including the 50 MW Bokpoort parabolic trough plant and 100 MW Redstone central receiver plant in South Africa, as well as ACWA Power's global portfolio of 1,360 MW solar thermal capacity.

  Research focuses on addressing real operational challenges in commercial CSP plants while advancing fundamental understanding of solar thermal technologies. The program combines industry-validated research with cutting-edge methodologies across five thematic areas: systems engineering and optimisation; autonomous monitoring and predictive maintenance; artificial intelligence and digital twins; component and sensor prototyping; and thermal engineering and power generation.

  Current research priorities include machine learning optimisation of large-scale heliostat fields, predictive maintenance using operational plant data, advanced thermal energy storage systems, and grid integration services. Projects range from immediate operational improvements that can be implemented within 1-2 years to fundamental research establishing next-generation CSP technologies.

  The research group maintains active collaborations with international CSP research networks and regularly participates in Horizon Europe programs. Students benefit from industry mentorship, access to commercial plant data, international collaboration opportunities, and potential for technology commercialisation through the ACWA Power partnership.

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Development of a mirror reflectivity measurement using drones Stellenbosch University has a collaboration with ACWA Power, the owner of 1,360 MW of solar thermal capacity worldwide, including the Bokpoort and Redstone CSP plants in the Northern Cape and the 510 MW Noor CSP complex in Morocco. Heliostat mirror reflectivity is a critical parameter affecting CSP plant performance, but current measurement methods are labour-intensive and provide limited spatial coverage across large heliostat fields. At utility-scale plants like Redstone with over 40,000 heliostats, comprehensive reflectivity monitoring is essential for maintaining optimal energy yield. This project aims to develop an automated drone-based system for comprehensive reflectivity measurement across heliostat fields. The research will design and integrate spectral measurement equipment with drone platforms, developing automated flight patterns for systematic field coverage. Key technical challenges include calibration procedures for varying illumination conditions, compensation for atmospheric effects, and data processing algorithms that convert raw measurements into actionable reflectivity maps. The system will incorporate GPS positioning for precise spatial mapping and real-time data processing for immediate identification of degraded mirrors. The research will be validated using operational data from ACWA Power facilities, providing access to commercial-scale CSP plants for testing and demonstration. This collaboration enables validation under real operating conditions while addressing genuine industrial challenges. The project offers opportunities for technology commercialisation and potential patent development, with results directly applicable to CSP facilities worldwide. **Requirements:** Programming skills, interest in drone systems and automation		✓	✓	✓

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Artificial Intelligence tool for solar field status management Stellenbosch University has a collaboration with ACWA Power, the owner of 1,360 MW of solar thermal capacity worldwide, including the Bokpoort and Redstone CSP plants in the Northern Cape and the 510 MW Noor CSP complex in Morocco. Current solar field monitoring at these facilities relies on manual data entry from drone surveys, daily performance evaluations, and visual inspections, creating delays and potential for human error in defect identification and management. With tens of thousands of components across large solar fields, efficient defect detection and classification are critical for maintaining plant performance and minimising maintenance costs. This project will develop an artificial intelligence system that automatically identifies and classifies defects from photographic data, converting results into formats compatible with existing plant management systems. The research will focus on computer vision algorithms trained on comprehensive datasets of CSP component conditions, including mirrors, absorber tubes, ball joints, collector structures, sensors, and hydraulic systems. The AI system will incorporate location and temporal data to track defect progression and prioritise maintenance activities. Machine learning models will be developed to recognise various defect types, assess severity levels, and integrate with existing plant databases. The tool will be designed for field operators to upload photos with location and time data, receiving automated defect classification and severity assessment for immediate integration into maintenance scheduling systems. Validation will be conducted using historical defect data from ACWA Power facilities, with performance benchmarking against current manual classification methods. The research provides opportunities for developing novel computer vision architectures while addressing real operational challenges in commercial CSP plants. **Requirements:** Programming skills, interest in machine learning and computer vision		✓	✓	✓

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Hybrid dry cooling retrofit for Bokpoort CSP plant Stellenbosch University has a collaboration with ACWA Power, the owner of 1,360 MW of solar thermal capacity worldwide, including the Bokpoort and Redstone CSP plants in the Northern Cape and the 510 MW Noor CSP complex in Morocco. The Bokpoort CSP plant currently employs wet cooling technology that consumes significant amounts of water in the arid Northern Cape region, where water scarcity is an ongoing concern. Converting to hybrid dry cooling could substantially reduce water consumption while maintaining acceptable plant performance and potentially extending operational capacity during peak summer conditions. This project will evaluate the technical feasibility and economic viability of retrofitting Bokpoort with hybrid dry cooling systems. The research will develop thermodynamic models of hybrid cooling configurations, analysing the trade-offs between water consumption, parasitic power consumption, and thermal performance under varying ambient conditions. The study will include detailed design of cooling system modifications, assessment of required infrastructure changes, and quantification of environmental benefits, including water savings and reduced environmental impact. Economic analysis will consider capital costs, operational savings, and payback periods, while environmental assessment will evaluate sustainability improvements and carbon footprint reduction. The research will utilise operational data from Bokpoort to validate models and establish baseline performance metrics. Water consumption reduction targets of 70-90% will be evaluated against efficiency penalties and capital investment requirements. The project addresses critical water sustainability challenges in arid regions while providing a framework for similar retrofits across ACWA Power's global portfolio and the broader CSP industry. **Requirements:** Thermodynamics, heat transfer, and programming skills for modelling and optimisation		✓	✓	✓
Design and analysis of glass alternative concentrating solar power reflectors Mirrored glass is the most common material for reflectors used in the concentrated solar power (CSP) industry. However, glass has many undesirable properties. The research aims to develop feasible glass alternative reflectors for CSP applications. The project will involve structural design, prototype building, and performance testing. Various simulation technologies can also be incorporated into the project. **Requirements:** none		✓	✓	✓

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Optimisation of cleaning strategies for the solar field of Redstone CSP Stellenbosch University has a collaboration with ACWA Power, the owner of 1,360 MW of solar thermal capacity worldwide, including the Bokpoort and Redstone CSP plants in the Northern Cape and the 510 MW Noor CSP complex in Morocco. The Redstone central receiver plant features 41,260 heliostats across several hundred hectares in the arid Northern Cape environment. Mirror soiling from dust accumulation significantly reduces optical efficiency, with studies showing that uncleaned mirrors can lose 0.1-0.5% reflectivity per day depending on weather conditions. Optimising cleaning strategies is therefore critical for maximising energy yield while minimising operational costs. This project will develop comprehensive cleaning optimisation models that account for soiling patterns, cleaning method effectiveness, labour productivity, and economic trade-offs. The research will evaluate available cleaning methods, including manual techniques and mechanised systems, quantifying productivity rates and cleaning effectiveness for each approach. Seasonal soiling factor analysis will be conducted using weather data, dust measurements, and reflectivity monitoring to establish predictive soiling models. The study will integrate heliostat performance data with cleaning cost analysis to develop economic optimisation algorithms that maximise electricity generation while minimising operation and maintenance expenses. Machine learning approaches will be applied to predict optimal cleaning schedules based on weather forecasts, energy prices, and plant dispatch requirements. The optimisation framework will consider spatial variations across the heliostat field, as mirrors in different locations experience varying soiling rates due to local topography and wind patterns. Validation will be conducted using operational data from Redstone, with potential for implementation across ACWA Power's global CSP portfolio. The research addresses a multi-million rand annual operational challenge while providing opportunities for developing novel optimisation algorithms applicable to large-scale industrial systems. **Requirements:** Programming skills, interest in optimisation, machine learning and data analysis		✓	✓	✓

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Predictive maintenance strategies for parabolic trough ball joints Stellenbosch University has a collaboration with ACWA Power, the owner of 1,360 MW of solar thermal capacity worldwide, including the Bokpoort and Redstone CSP plants in the Northern Cape and the 510 MW Noor CSP complex in Morocco. Ball joints in parabolic trough systems are critical components that enable collector tracking while accommodating thermal expansion and structural flexing. These joints operate under extreme conditions including high temperatures (up to 400°C), thermal cycling, mechanical loading, and exposure to dust and weather in desert environments. Ball joint failures can result in collector tracking errors, reduced energy yield, and costly unplanned maintenance outages. This project will analyse the mechanical and thermal stresses affecting ball joints in parabolic trough systems using finite element analysis and operational data from Bokpoort. The research will evaluate current operational practices and identify failure modes in ball joint assemblies through systematic analysis of maintenance records and field inspection data. A predictive maintenance framework will be developed using machine learning techniques to forecast component degradation based on operating conditions, thermal cycling patterns, and environmental factors. The study will propose optimised operational strategies that mitigate wear and extend component life through intelligent scheduling of cleaning cycles, tracking patterns, and preventive maintenance. Validation will be conducted through simulation, field data analysis from ACWA Power facilities, and comparison with existing maintenance protocols. The research addresses real operational challenges while providing opportunities for developing novel predictive maintenance methodologies applicable to other high-temperature mechanical systems. Outcomes include improved plant availability, reduced maintenance costs, and enhanced understanding of component degradation mechanisms in concentrated solar power applications. **Requirements:** Finite element analysis, programming skills, interest in mechanical systems and predictive maintenance		✓	✓	

Dr Michael Owen
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- **Research Field**
  Heat transfer, thermodynamics, fluid mechanics
- **General Description of Research Field**
  Overall my research aims to contribute to sustainable production, use and manipulation of thermal energy. I make use of a combination of experimental, numerical (typically by means of CFD) and analytical methods to investigate thermodynamic cycles, thermal energy systems and components at a number of levels including high level feasibility analysis, system testing and analysis and component-level testing and simulation. There is a strong focus on industrial heat exchangers and cooling towers in particular (dry, wet and hybrid), as these systems directly affect thermal power plant efficiency (fossil-fuelled, nuclear and renewable) and have a direct influence on the energy/water nexus.

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Reduced-order modelling of air-cooled condenser performance under windy conditions Air-cooled condensers (ACCs) are a direct dry cooling technology that significantly reduces the water footprint of thermal power generation. These systems are widely used in concentrating solar power (CSP) plants since these plants are typically built in arid regions with high solar resource but limited water availability. The performance of the condenser direclty impacts the thermal efficiency of the power plant (by influencing the turbine back pressure) and is thus a critical (but often overlooked) component in the power cycle. The majority of ACCs are mechanical draft systems where air flow is driven by large axial fans. As an alternative, natural draft systems use bouyancy as the motive force and thus eliminate the need for fans (thus offering benefits in terms of net power output). There is currently only one natural draft ACC at a CSP in the world (Khi Solar 1, Upington South Africa), and the relative performance and costs (compared to mechanical draft systems) are not well understood. Ultimately, our aim is to conduct a direct comparison of mechanical and natural draft ACCs for application in CSP based on life-cycle cost. This comparison requires an understanding of how these two systems would perform over a typical meteorological year in a representative location (taking into account ambient conditions including temperture and wind). In this project, we will develop a reduced order model of the performance of a mechanical draft ACC (using CFD simulations to generate training data) as a function of both ambient temperature and wind. This model will be applied in the overarching comparitive study mentioned previously.		✓		

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Requirements: The project requires the student to have completed, or to do, a CFD module (or have relevant experience with CFD). ANSYS FLUENT is the preferred software.				
Optimising specific energy consumption in raceway ponds for large scale aquafarming of seaweed for biofuel generation Seaweed is emerging as prominent resource in the transition to sustainability in many industries. A common type of farming occurs in onshore ponds, where the seaweed is kept in suspension using aeration or paddle wheels to introduce turbidity into the water. A key parameter for the economic feasibility of any land-based aquaculture project is the energy required to keep the seaweed suspended. This study will use numerical models to optimise raceway pond geometry for minimum specific energy consumption while maintaining adequate turbidity distribution. This project will be co-supervised by Dr Adam Venter and will be in collaboration with an industry partner. **Requirements:** CFD		✓		

Prof Hannes Pretorius
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- **Research Field**
  Thermofluids
- **General Description of Research Field**
  Simulation of dry cooling systems for power generation applications; Simulation of turbomachinery for supercritical CO_2 power cycles; Axial flow fan performance; Thermo-economic evaluations

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Numerical simulation of mitigation strategies for wind-induced performance degradation in Natural Draft Air-Cooled Condensers for Concentrated Solar Power applications Concentrated Solar Power (CSP) plants are anticipated to contribute to the reduction of global carbon dioxide emissions by providing an alternative for dispatchable power compared to conventional fossil fuel power generation. However, their deployment is hindered by comparatively high capital costs relative to other renewable technologies, such as photovoltaic (PV) and wind energy systems. To be competitive, CSP plants therefore need to be as thermally efficient as possible, while adhering to stringent water conservation efforts in the typically arid or semi-arid regions in which they are constructed. Natural Draft Air-Cooled Condensers (NDACCs) represents a modern evolution to direct condensation of the working fluid in steam power cycles using dry-cooling methods compared to traditional mechanical draft Air-Cooled Condensers (ACCs). By eliminating the requirement for mechanically driven fans, these systems offer reduced operating costs and enhance the net power output of the cycle by reducing auxiliary power consumption. Despite their benefits, recent research has shown that NDACCs exhibit comparable performance degradation to ACCs under windy conditions. Although numerous publications have explored strategies to mitigate wind-related performance losses in ACCs, minimal research has been conducted on similar mitigation strategies for NDACCs. This study investigates measures to mitigate against performance degradation under wind for a NDACC sized for a 50 MWe CSP application. A Computational Fluid Dynamics (CFD) model of the NDACC is developed, validated, and used to simulate the performance of reference and modified system configurations under calm and windy conditions. Various wind-breaker mechanisms, including extended clapboard and screens, louvers, extended baffles and internal wind-cross are evaluated, while the effect of porosity and combined mechanisms are also assessed. (NOTE: This topic has already been allocated to a student for 2026.) (This project will form part of research conducted by the Solar Thermal Energy Research Group) **Requirements:** Strong interest and performance in Thermo-fluids modules. Computational Fluid Dynamics.		✓		

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Comparative techno-economic assessment of dry cooling system alternatives for a 50 MWe concentrating solar power (CSP) application Modern thermal power plants in arid and semi-arid locations employ water conserving dry cooling technologies to reject the required heat from the cycle to the environment. Among these technologies are traditional mechanical draft air-cooled condensers (ACCs), natural draft indirect dry cooling systems and a new alternative, the natural draft air-cooled condenser (NDACC). ACCs employ a multitude of large diameter axial flow fans to force airflow across heat exchanger bundles. The capital cost of these systems is relatively low, but operational costs are high due to parasitic power consumption and maintenance cost on the many moving parts. Direct steam condensation inside the finned tubes of the heat exchangers ensures high thermal efficiencies. In contrast, natural draft indirect dry cooling systems use the natural draft created by buoyancy effects to drive airflow through a large cooling tower, and across heat exchanger bundles around the tower periphery at ground level. Such systems utilize a shell-and-tube condenser to condense the turbine exhaust steam, while a separate loop pumps the cooling water to be re-cooled in the cooling tower. Due to their large footprint, these systems have high capital costs, but operational costs are much reduced compared to the ACC due to the reduced rotating mechanical equipment requirement. Indirect steam condensation to cooling results in lower thermal efficiencies compared to direct systems. The NDACC combines the advantages of reduced operational cost of a natural draft system with the higher thermal efficiencies of direct steam condensation, as steam is conveyed directly from the turbine exhaust into heat exchangers situated inside a natural draft cooling tower. This study will evaluate the Levelized Cost of Electricity (LCOE) for each cooling option, as part of a 50 MWe concentrating solar power plant. The investigation will build on one-dimensional thermo-fluid models which have been developed for each of these systems to evaluate the performance of each over an annual basis. Costing models will also be developed towards performing the techno-economic evaluation for each alternative. Additionally, the sensitivity of LCOE to variations in load profile, geographic location, and electricity tariff structures is assessed. (NOTE: This topic has already been allocated to a student for 2026.) (This project will form part of research conducted by the Solar Thermal Energy Research Group) **Requirements:** Strong interest and performance in Thermo-fluids modules.		✓		

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Sensitivity analysis on a natural draft air-cooled condenser (NDACC) for large- and medium-scale power generation applications Modern thermal power plants in arid and semi-arid locations employ water conserving dry cooling technologies to reject the required heat from the cycle to the environment. Among these technologies are traditional mechanical draft air-cooled condensers (ACCs), natural draft indirect dry cooling systems and a new alternative, the natural draft air-cooled condenser (NDACC). ACCs employ a multitude of large diameter axial flow fans to force airflow across heat exchanger bundles. The capital cost of these systems is relatively low, but operational costs are high due to parasitic power consumption and maintenance cost on the many moving parts. Direct steam condensation inside the finned tubes of the heat exchangers ensures high thermal efficiencies. In contrast, natural draft indirect dry cooling systems use the natural draft created by buoyancy effects to drive airflow through a large cooling tower, and across heat exchanger bundles around the tower periphery at ground level. Such systems utilize a shell-and-tube condenser to condense the turbine exhaust steam, while a separate loop pumps the cooling water to be re-cooled in the cooling tower. Due to their large footprint, these systems have high capital costs, but operational costs are much reduced compared to the ACC due to the reduced rotating mechanical equipment requirement. Indirect steam condensation to cooling results in lower thermal efficiencies compared to direct systems. The NDACC combines the advantages of reduced operational cost of a natural draft system with the higher thermal efficiencies of direct steam condensation, as steam is conveyed directly from the turbine exhaust into heat exchangers situated inside a natural draft cooling tower. This study will conduct a sensitivity analysis on the performance of a NDACC for changes to the heat exchanger configuration, heat exchanger performance characteristics, tower geometry and shape, and inclusion of wind mitigation measures. The investigation will build on current Computational Fluid Dynamics (CFD) models of a NDACC which have been developed for medium (100 MW CSP) and large (900 MW thermal) scale power generation applications. CFD simulations will be executed based on the updated geometries and features and the impact on system performance assessed. (This project will form part of research conducted by the Solar Thermal Energy Research Group) **Requirements:** Strong interest and performance in Thermo-fluids modules. Computational Fluid Dynamics.		✓		

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Multi-objective optimisation of a natural draft air-cooled conder using deep-learning Natural draft air-cooled condensers (NDACCs) are a promising new alternative for heat rejection systems in thermal power plants. These technologies minimise water use, eliminate parasitic power consumption and reduce maintenance costs. NDACCs are sensitive to changes in ambient conditions, which deteriorate cooling performance, increasing turbine back pressure and reducing power plant efficiency. However, these applications exhibit a large design parameter space that can be explored to obtain an optimal solution during design point conditions to minimise these performance changes. The operational resilience and robustness of the system geometry can further be enhanced by investigating off-design operating conditions, such as changes in plant load or varying ambient temperature and crosswinds. Therefore, a system geometry can be determined that covers a vast design and operational variable space, ensuring an efficient and durable solution. This study aims to perform multi-objective optimisation with the use of deep-learning based neural networks to find an optimised NDACC design under the full range of expected operational conditions. The design space consists of varying ambient temperatures and crosswinds, plant loads, as well as tower and heat exchanger geometric parameters and wind mitigation features. A computational fluid dynamics model (CFD) of the cooling system will be used to generate the required performance data from a design of experiments (DOE) that varies the design variables, boundary conditions and operational conditions across the design space. A deep-learning based surrogate model is subsequently trained on the CFD output data to find an optimal NDACC configuration. (NOTE: This topic has already been allocated to a student for 2026.) (This project will form part of research conducted by the Solar Thermal Energy Research Group, and will be co-supervised by Prof Ryno Laubscher) **Requirements:** Strong interest and performance in Thermo-fluids modules. Computational Fluid Dynamics.			✓	

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Design of an axial-flow cooling fan for enhanced supercritical carbon dioxide air-cooled heat exchanger performance Concentrated Solar Power (CSP) plants are expected to play an important role towards the stabilisation of power grids where intermittent renewable energy generation sources are becoming increasingly prevalent. However, these plants have not seen the same implementation rates as wind and photovoltaic solar plants, due to high capital costs. By combining the CSP plant with advanced supercritical carbon dioxide (sCO2) cycles, thermal efficiencies and cost-effectiveness can be significantly enhanced. CSP plants typically employ mechanical draft dry cooling systems to conserve water in the arid or semi-arid areas where these plants are located. These air-cooled heat exchangers (ACHEs), which operate using axial-flow fans, have a major impact on the efficiency of the power cycle. It is therefore critically important that these systems are designed to operate optimally. Recent studies into the axial-flow fan design for SCO2 ACHEs have highlighted potential areas of improvement. This study therefore performs a re-design, simulation and test of such an axial-flow fan, based on a revised sCO2 ACHE specification and fan design point, with the intention of enhancing overall cooling system performance. (NOTE: This topic has already been allocated to a student for 2026.) (This project will form part of research conducted by the Solar Thermal Energy Research Group, and is co-supervised by Prof Johan van der Spuy) **Requirements:** Strong interest and performance in Thermo-fluids modules. Computational Fluid Dynamics.		✓		
Evaluating the impact of operational and wind effects on cooling fan performance for a supercritical carbon dioxide (sCO2) air-cooled heat exchanger Mechanical draft air-cooled heat exchangers can be used as coolers for supercritical carbon dioxide (sCO2) Brayton cycles which form part of Concentrated Solar Power (CSP) plants. Prevailing winds typically have a major effect on the fan performance of air-cooled heat exchangers. In addition, it is important to understand multi-fan interactions and the impact of non-operational fans within a bank of fans which form part of the heat exchanger design. This study will evaluate the effects of prevailing winds over a range of velocities and directions, as well as operational outage scenarios, on the performance of the fans and heat exchanger. The performance of the system will be simulated using a co-simulation method, where the sCO2-side is simulated using a one-dimensional code (Python), coupled to a Computational Fluid Dynamics model (Fluent) which simulates the air-side. (This project will form part of research conducted by the Solar Thermal Energy Research Group, and is co-supervised by Prof Johan van der Spuy)		✓		

Topics	**MEng Struct**	**MEng Resrch**	**PhD**	**Potential Funding**
Requirements: Strong interest and performance in Thermo-fluids modules. Computational Fluid Dynamics.				
Performance modelling of axial compressors for a supercritical carbon dioxide (sCO2) power cycle Concentrated Solar Power (CSP) is a renewable energy source that generates electricity using direct solar radiation. CSP complements traditional energy sources like coal, natural gas, and nuclear. Environmental fluctuations and varying output requirements impact CSP plants' thermal and economic performance, causing efficiency reductions when operating off-design. Consequently, large and costly CSP plants are needed to meet energy demands. Techno-economic analyses indicate that improving power block efficiency can significantly reduce costs. Global research interest into supercritical carbon dioxide (sCO2) power cycles is increasing, due to their superior efficiencies and reduced component size requirements. These cycles, linked to CSP applications represent a modern evolution to sustainable and efficient power production. The design of turbomachinery for sCO2 cycles is critical, as efficiency greatly affects the system. The unique properties of CO2 in the critical region pose challenges, prompting extensive research. One-dimensional (1D) mean-line models are favoured for analysis and design due to their lower computational cost compared to three-dimensional (3D) Computational Fluid Dynamics (CFD) models. Choosing suitable loss correlations is key for accurate turbomachinery modelling and reliable efficiency results. This work aims to design efficient axial compressors for a 50 MWe CSP plant using a sCO2 power cycle. This involves preliminary compressor designs as well as developing 1D models that account for the real gas effects of CO2 and various loss mechanisms. Additionally, CFD simulations will validate the compressor designs at their selected operational speeds. (This project will be co-supervised by Prof Ryno Laubscher and will form part of research conducted by the Solar Thermal Energy Research Group) **Requirements:** Strong interest and performance in Thermo-fluids modules. Computational Fluid Dynamics.		✓		

Dr Boitumelo Ramatsetse
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- **Research Field**
  Reconfigurable Manufacturing Systems, Advanced Manufacturing Systems, Maintenance Systems and Life Cycle Assessment

- **General Description of Research Field**
  Reconfigurable Manufacturing Systems (RMS) are complex type of manufacturing systems designed to respond or address changes in demands in the manufacturing industry. Unlike dedicated manufacturing systems (DMS) and flexible manufacturing systems (FMS), which are often rigid and specialized for specific tasks or products, RMS are designed to be responsive to changes in product designs, production volumes, and process requirements. The most important Reconfigurable Manufacturing Systems (RMS) characteristics includes modularity, integrability, customization, convertibility and diagnosability. Reconfigurable Manufacturing Systems offer manufacturers a more agile and responsive approach to production, allowing them to adapt quickly to changing market demands and maintain a competitive edge in today's dynamic manufacturing environment. Thus, my research niche will focus on design of reconfigurable mobility platforms and systems to support integration of digital technologies for maintenance activities in various manufacturing industries.

Topics	**MEng Struct**	**MEng Resrch**	**PhD**	**Potential Funding**
Energy-Efficient Reconfiguration Strategies in Manufacturing Systems Reconfigurable Manufacturing Systems (RMS) are designed for rapid structural, hardware, and software modifications to meet fluctuating production demands and diverse product families (Koren, 1998). A central element of RMS is the Reconfigurable Machine Tool (RMT), which embodies the system's core principles such as scalability, modularity, convertibility, integrability, diagnosability, and customized flexibility. While significant research has been conducted on the structural and functional adaptability of RMS, limited attention has been given to the energy efficiency strategies associated with reconfiguration process, such as machine setup, operational transitions, and idle states. Thus, this PhD project aims to investigate and minimize energy consumption during reconfiguration processes in RMS through a combination of modeling, simulation, and experimental validation. The study will model energy flows across different machine states (setup, operation, idle) and develop intelligent control strategies for optimizing power usage. This work forms part of the ongoing research project (REF: CSRP23030881449) funded by National Research Foundation (NRF) consisting of partners from Tshwane University of Technology (TUT) & University of Johannesburg (UJ) to develop innovative reconfigurable manufacturing systems (RMS) solutions for addressing challenges in manufacturing industries. This research is led by the Principal Investigator (PI) Dr. Ramatsetse (NRF Y-Rated Researcher) and will be supported by the NRF-DSTI Chair in Future Transport Manufacturing Technologies. At this stage, funding is available only for the development of prototype solutions. Additional research funding will be sourced through the Technology Innovation Agency (TIA) seed funding programme. Upon selection of the topic, the candidate will be guided with the application of NRF Masters Scholarship using the project reference number. Should the application be successful, the candidate will be based full-time at Stellenbosch Campus, Mechanical & Mechatronics (M&M) building. **Requirements:** The prospective candidate must have sufficient scientific or engineering background in one or more of the following: Computer Aided Design (CAD), Mechanical Machine Design, Control Systems, Finite Element Analysis etc.			✓	

Dr Clint Steed
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- **Research Field**
  Production Engineering | Engineering training and education | Socio-technical system

- **General Description of Research Field**
  (1) Virtual Prototyping of Manufacturing Assembly Systems

  Manufacturing assembly is a critical generator of economic value, with human operators remaining essential to system performance. While Industry 4.0 was largely techno-centric, Industry 5.0 introduces a human-centric paradigm that emphasizes technologies which are practical, applicable, and socially sustainable.

  This research applies state-of-the-art tools to support resilient (reconfigurable) manufacturing assembly, contributing to the revitalization of South Africa's declining manufacturing sector. Virtual prototyping enables the development of solutions tailored to small-scale manufacturing, allowing SMEs to respond rapidly to market fluctuations and to leverage advanced technologies in ways that are often inaccessible to larger firms.

  (2) Virtual Reality in Engineering Training and Education

  The demand for engineering training is increasing, with growing class sizes and technological disruptions requiring large-scale retraining. The ability to scale engineering experience is therefore of strategic importance.

  Virtual reality provides a viable means of offering industrially relevant learning experiences when physical site visits are impractical or unsafe. It also facilitates immersive, practice-oriented training that enhances learning outcomes. Gamification has demonstrated improvements in knowledge retention among both students and professionals, though it requires significant development resources. Furthermore, technological transitions, such as the shift from internal combustion engines to electric vehicles, highlight the urgent need for scalable retraining solutions.

  By integrating virtual training environments into engineering education, learners can engage with advanced technologies at scale, overcoming barriers of cost, accessibility, and safety.

  (3) The African Infrastructure Transition

  Africa's development context is shaped by a large and dispersed rural population, which challenges conventional assumptions about infrastructure. Centralized, capital-intensive systems, common in industrialized nations, are often unsuitable for African realities due to their high costs and cultural misalignment.

  This research explores alternative, African-centric infrastructure models that prioritize cultural relevance and social acceptance while addressing urgent development needs. Leapfrogging conventional infrastructure pathways may provide more sustainable and equitable solutions for the continent.

  "It is important to remember that technology should serve people, and not the other way around."

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
The African Infrastructure Transition Africa is characterized by a large rural population that is sparsely distributed. This situation demands a re-examination of common infrastructure assumptions. Aging and expensive infrastructure, designed for centralized and globally integrated cultures, is often poorly suited to African contexts. The question here is simple: should we not consider African-centric solutions, thereby leapfrogging much of the proposed infrastructural change? A few examples come to mind. If you had the choice, would you not prefer to cook by fire? This line of investigation examines solutions to current problems in ways that respect local cultures and the people affected by them. “It is important to remember that technology should serve people, and not the other way around.” I'm currently investigating: 1. Low-cost solar PV 2. Direct DC low-cost mini-grid solutions 3. Cultural and circular cooking methods (Rocket stoves). **Requirements:** Strong sense of community or engineering for the greater good. Good sense of practical engineering knowledge, Determination and patience.		✓	✓	✓

Dr Gerrit Ter Haar
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- **Research Field**
  Overcoming metal corrosion degradation in hydrogen cells
- **General Description of Research Field**
  Metal corrosion is a significant challenge in hydrogen electrolyzers and fuel cells, primarily due to the harsh electrochemical environments present in these devices. In electrolyzers, the anode experiences highly oxidizing conditions during the oxygen evolution reaction, leading to corrosion of metallic components. This corrosion can result in the degradation of electrode materials, reduced efficiency, and contamination of the produced hydrogen. This metal degradation not only diminishes the performance and lifespan of the devices but can also lead to the release of metal ions that may poison catalysts or contaminate membranes. Consequently, the development of corrosion-resistant materials and protective coatings is crucial for enhancing the durability and efficiency of hydrogen electrolyzers and fuel cells. Corrosion-resistant materials such as titanium are popular, but expensive. Therefore, to reduce costs, materials engineers are investigated alternative approaches. One such approach is in using low-cost material (e.g., stainless steel) and applying ani-corrosive surface treatments. This project entails investigating cheaper alternative materials, characterising them and validating their performance in an anodic environment that matches that of real-world cell conditions. Potential funding is available.

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Smart Hydrogen Lab: Development of an Automated Electrolyzer Test Bench This project involves designing and constructing a comprehensive, budget-conscious automated test bench for PEM water electrolysis characterization. Students will integrate low-cost sensors, microcontroller-based control systems, and data acquisition hardware with the existing Gamry potentiostat setup. The system will feature automated testing protocols, real-time monitoring of key parameters (temperature, pressure, flow rates, gas purity), gas detection systems for safety monitoring, user-friendly interface design, and cloud-based data logging. The project combines mechatronic design, programming, and process control engineering to create a platform that can run standardized performance tests, durability studies, and efficiency optimization experiments. Students will gain hands-on experience with industrial automation concepts while contributing to hydrogen energy research infrastructure. **Requirements:** none	✓	✓		✓

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Precision Stamping Manufacturing of High-Performance Bipolar Plates for Hydrogen Production This manufacturing-focused project develops cost-effective stamping processes for producing high-precision bipolar plates with complex flow field geometries. Students will design and optimize stamping dies, conduct material formability studies, and establish quality control protocols for dimensional accuracy and surface finish. The research includes finite element analysis of the stamping process, material selection based on formability and electrochemical performance, and development of automated production workflows. Key deliverables include process parameter optimization, tooling design specifications, and economic feasibility analysis comparing stamping to alternative manufacturing methods. The project provides hands-on experience with precision manufacturing, tool design, and production scaling while addressing the critical need for cost-effective hydrogen energy component manufacturing. **Requirements:** none		✓		
Advanced Porous Transport Layer Engineering: Multiscale Design for Enhanced Hydrogen Production This cutting-edge research project focuses on designing and manufacturing next-generation porous transport layers (PTLs) with engineered microstructures for optimal electrolyzer performance. Students will develop laser process parameter optimization combined with fine lattice structure CAD design for 3D-printed titanium mesh architectures with gradient porosity designs. The research encompasses multiscale engineering from nanoscale surface functionalization to macroscale mechanical properties, including water management enhancement through controlled wettability. Advanced characterization includes porosity analysis, electrical/thermal conductivity measurements, mechanical property testing, and in-situ testing of the PTL in a single cell PEM water electrolyzer. CFD analysis may be incorporated depending on student skills. The project combines materials science, CFD, and additive manufacturing to push the boundaries of hydrogen production efficiency and durability. **Requirements:** none		✓	✓	✓

M.Sc. M.Sc. Paul Thiele
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- **Research Field**
  Hydrogen Engineering
- **General Description of Research Field**
  I investigate the integration of hydrogen into the renewable energy system. This includes electrolysis to produce hydrogen from electrical energy and fuel cells to generate electrical energy again from hydrogen. These technologies are used in combination as energy backup and to fuel hydrogen vehicles. To optimise such systems, artificial intelligence and machine learning methods will play a big role in the future for optimizing the hybrid strategy of the system with respect to energy efficiency but also lifetime improvement. Therefore, degradation analysis and mitigation are other aspects of the research.

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Digital Twin Development for H2 Microgrid-Refuelling Station Components Advanced simulation modelling for integrated hydrogen infrastructure systems Hydrogen microgrid-refuelling station systems represent a cutting-edge solution for South Africa's energy security challenges, enabling long-term storage of renewable energy through hydrogen conversion. These systems store electricity from solar and wind power as hydrogen via electrolysis, providing energy independence during periods of low renewable generation or grid instability (see https://www.iwu.fraunhofer.de/en/press/2025-Hydrogen-Microgrids-Make-Sun-and-Wind-Storable.html for technical background). By storing excess solar and wind energy as hydrogen, these integrated systems provide both grid stabilisation and clean transportation fuel, bridging the gap between intermittent renewable generation and continuous energy demand. Develop comprehensive digital twin models for individual components of hydrogen microgrid-refuelling station systems. Focus on high-fidelity simulation models with detailed parameterisation and experimental validation for components such as electrolysers, fuel cell systems, high-pressure storage vessels, or dispensing units. Apply advanced modelling techniques including multi-physics simulations, thermal dynamics, and electrochemical processes to enable grid-independent renewable hydrogen production. **Requirements:** Some pre-knowledge in modelling and renewable energy technologies beneficial		✓	✓	✓

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
AI/ML Optimisation of Integrated H2 Microgrid-Refuelling Systems Machine learning approaches for intelligent energy management and control Hydrogen storage offers significant advantages over battery storage for renewable energy systems, particularly its very low self-discharge rate making it ideal for seasonal energy storage and bridging "dark doldrums" when there is no wind or sunshine. Combined hydrogen microgrid-refuelling station systems address the critical challenge of renewable energy intermittency by using hydrogen as a chemical battery to store excess solar and wind energy during peak production periods. The produced hydrogen can either be reconverted to electricity during shortages or load shedding events or be used to refuel hydrogen powered vehicles (technical details: https://www.iwu.fraunhofer.de/en/press/2025-Hydrogen-Microgrids-Make-Sun-and-Wind-Storable.html). Develop and implement advanced artificial intelligence (AI) and machine learning (ML) algorithms for optimal operation of these integrated systems that maximise renewable energy utilisation through intelligent power-to-hydrogen conversion. Focus can include, among others, neural network-based control strategies, reinforcement learning for energy management, predictive maintenance algorithms, and degradation mitigation through intelligent operation. Address challenges of grid instability, load balancing, and autonomous system operation while maintaining continuous energy supply from stored renewable hydrogen when grid power is unavailable. **Requirements:** Some pre-knowledge in modelling and renewable energy technologies beneficial		✓	✓	✓

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Degradation Analysis & Lifetime Modelling of H2 Infrastructure Components Comprehensive lifetime assessment for sustainable hydrogen infrastructure Hydrogen microgrid-refuelling systems enable long-term storage of renewable energy by converting excess solar and wind power to hydrogen via electrolysis, providing energy security during grid instability and load shedding events (see https://www.iwu.fraunhofer.de/en/press/2025-Hydrogen-Microgrids-Make-Sun-and-Wind-Storable.html for microgrid functionality). These systems designed for seasonal energy storage face unique operational challenges, particularly when capturing abundant solar energy during summer months and storing it as hydrogen for use during winter periods when solar irradiation is reduced. Components must withstand frequent charge-discharge cycles as renewable energy availability fluctuates, requiring robust infrastructure design for renewable energy integration in regions with seasonal variations and grid instability. Conduct detailed degradation analysis and lifetime modelling of critical components in hydrogen microgrid-refuelling systems that enable seasonal energy storage from renewable sources. Focus includes accelerated ageing studies, degradation mechanism identification, materials characterisation, and predictive lifetime modelling for PEM electrolysers and fuel cells operating under cyclic renewable energy conditions. Develop reliability-centred maintenance strategies for components operating in challenging renewable energy integration scenarios. **Requirements:** Some pre-knowledge in electrochemical processes beneficial		✓	✓	✓

Dr Adam Venter
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- **Research Field**
  Aerodynamics, Computational Fluid Dynamics, Turbomachinery
- **General Description of Research Field**
  Computational fluid dynamics modelling, principally encompassing: the design and analysis of next-generation aerodynamic architectures; the development of robust low-fidelity turbomachine rotor models for large-scale industrial system analyses, and high-fidelity modelling of renewable energy systems.

Topics	**MEng Struct**	**MEng Resrch**	**PhD**	**Potential Funding**
Open-source modelling of large-scale wind turbine farms A range of potential topics in wind-farm modelling, using cost-efficient open-source modelling codes, will be on offer in collaboration with an industry partner. These projects will only be defined towards the end of the year in partnership with the collaborator. If you are interested in pursuing a project in the renewable energy field and working closely with industry, please contact Dr. A. Venter to be added to the waitlist for more info on these potential projects. **Requirements:** CFD		✓	✓	

Prof Martin Venter
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- **Research Field**
  Generative Design, Machine Learning, Material Modelling, Soft Robots and Inflatables, simulation of biomaterials

- **General Description of Research Field**
  I am interested in computational methods as part of the design process. This allows us to share the burden of making design decisions that can become complex, like biologically inspired artificial creatures and inflatable structures. Over the past few years, I have been exploring the potential applications of compliant and selectively reinforced materials in the fields of pressure-rigidised structures and soft robotics. In addition, our research group is interested in combining powerful non-linear simulation tools, such as finite element methods, with the ever more important field of machine learning in a modern generative design approach.

  This is a multidisciplinary field taking elements from several computational fields. Researchers in this area will develop non-linear finite element methods, numerical design optimisation, programming and machine learning skills. Much of what we do requires insightful experiment planning in tandem with advanced tools to deal with large volumes of data. This new field is open to exploration, which can be both challenging and rewarding.

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Gearbox Loading Estimation for Next-Generation Offshore Wind Turbines The Challenge of Modelling Extreme Loads in Offshore Wind Turbines As the wind energy industry moves into deeper waters, offshore wind turbines are evolving into colossal structures. The next generation of turbines will have blades exceeding 150 meters in length mounted on 200-meter-high floating platforms. However, their sheer size and location expose them to a confluence of extreme and complex environmental loads. The drivetrain, particularly the gearbox, is the critical link that transfers the kinetic energy of the rotating blades into electrical power. This gearbox is subjected to a unique combination of aerodynamic forces, wave-induced motions, and the platform's dynamic response, resulting in highly variable and unpredictable loading. Accurately predicting these loads is crucial for ensuring the reliability and longevity of the turbine, preventing costly failures, and advancing the design of these immense machines. This project addresses this challenge by creating a dynamic computational model of an entire offshore wind platform. The model will integrate all realistic load sources to provide a comprehensive and accurate estimation of the forces and moments acting on the gearbox. This research will move beyond static or simplified models and provide a vital tool for engineers designing the next generation of these essential renewable energy systems. Research Aims and Objectives The primary goal of this research is to develop a dynamic, multi-domain model of a floating offshore wind turbine to estimate gearbox loading accurately. The specific objectives are: Objective 1: Model the Aerodynamic and Hydrodynamic Loads. The student will begin by developing sub-models for the two primary environmental load sources. This includes an aerodynamic model of the massive rotating blades and a hydrodynamic model of the floating platform's interaction with waves and currents. Objective 2: Integrate the System Dynamics. The core of the project is to integrate the sub-models into a single, cohesive dynamic system model. This will involve using multi-body dynamics software to simulate the complex coupled motions of the floating platform, tower, and nacelle in response to the applied forces. The model will need to account for gyroscopic effects and the non-linear coupling between the different domains. Objective 3: Estimate and Analyse Gearbox Loading. The model will be used to simulate the turbine's operation under various realistic environmental conditions (e.g., different wind speeds, wave heights, and turbulence levels). The student will then extract and analyse the resulting forces and moments at the gearbox to determine peak loads, fatigue cycles, and the overall load spectrum. Objective 4: Validate the Model. The student will validate the model by comparing its predictions against existing experimental data from scaled-down prototypes or publicly available data from similar full-scale systems. This will ensure the model is robust and its predictions are reliable..		✓	✓	

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Requirements: Students who will thrive in this project will have an interest in structural, fluid and dynamic simulation and programming.				

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Key Technologies for Integrated Offshore Floating Photovoltaic-Wave Energy Converter Equipment The Challenge of Harnessing Coastal Renewable Energy South Africa, with its extensive coastline, possesses a vast and largely untapped renewable energy resource in its coastal waters. While land-based solar and wind projects are expanding rapidly, the potential of the ocean, specifically solar and wave energy, remains underexplored. A hybrid system that integrates both floating solar photovoltaic and wave energy converters into a single platform offers a powerful solution. Such a system can provide a more consistent energy output than a single source, as solar and wave resources often peak at different times of the day or year. However, designing a single, stable, and cost-effective platform that can efficiently harness both forms of energy is a complex challenge, requiring a deep understanding of hydrodynamics, structural engineering, and systems integration. This project aims to address this challenge by developing a location-specific design methodology for a hybrid floating platform. The research will not only provide a theoretical and technical framework for future floating platform research in South Africa but also demonstrate the socio-economic benefits of this technology, encouraging the country to open a new renewable energy market and contribute to its energy security. Research Aims and Objectives The primary goal of this research is to design, model, and validate a location-specific floating platform that integrates both photovoltaic and wave energy conversion. The specific objectives are: Objective 1: Site Identification and Characterisation. The student will begin by identifying and evaluating potential deployment sites in South Africa and, for a comparative analysis, in China. This will involve an analysis of environmental data, including wave characteristics, solar irradiance, sea state variability, and other relevant parameters for hybrid energy generation. Objective 2: Environmental Modelling and Resource Assessment. Based on the identified sites, the student will define the specific coastal and marine conditions at each location. This will involve using modelling software to create realistic environmental models that capture wave characteristics and solar irradiance, providing the necessary inputs for the platform design simulations. Objective 3: Design Concept Development. The student will develop an initial conceptual design for a hybrid PV-wave energy system to serve as a common baseline. This design will be a versatile platform that can be adapted to different environmental conditions. The design will integrate the two energy technologies, for example, by incorporating wave energy converters within the platform's mooring or structural elements. Objective 4: Comparative Design Evaluation. Using the baseline model, the student will adapt the design to be site-specific, optimising its performance based on the local environmental conditions of the chosen South African and Chinese sites. This will involve using a design-by-simulation approach, likely with multi-domain modelling software, to assess energy output, structural resilience, and cost-effectiveness across both regions. The outcome will be a validated design method that can be applied to other locations in the future.		✓	✓	

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Requirements: Students who will thrive in this project will have an interest in simulation, programming and providing practical solutions to broadly framed problems.				

Prof Johan van der Spuy
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- **Research Field**
  Turbomachinery
- **General Description of Research Field**
  1) The use of direct dry-cooling in power generation systems is a means of ensuring sustainable water usage. The efficient, low noise, operation of the axial flow fans that form part of such an air-cooled system is essential for a well-performing system. These research topics (topics 1, 2 and 3) focus on the design, testing and analysis of axial flow fans for these systems. 2) The use of micro gas turbines (MGTs) for the propulsion of aerial vehicles or solar thermal power applications hold specific advantages. The topic is related to the development of a turboshaft micro gas turbine.

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Analysing the performance of the 24 ft. installed MinwaterCSP axial flow fan. The project will specifically focus on modelling and accurately measuring the performance of the 24 ft MinwaterCSP axial flow fan. Existing work has focused on the measurement and modelling of this fan's performance under stable conditions. The idea is to expand this work in order to improve the fan's performance under various operating conditions. The possible improvements will be modelled in CFD and implemented in a digital representation of the Minwater facility (read: Digital Twin). **Requirements:** Numerical Fluids 414		✓	✓	✓
Design of a cooling fan for enhanced sCO2 air-cooled heat exchanger efficiency Co-supervision with Prof JP Pretorius A previous student successfully designed a fan for an sCO2 air-cooled heat exchanger. However, further work showed that there is potential for re-designing the fan and possibly improving its performance by reconsidering the design parameters. The project will involve the complete design, build, test and numerical analysis of the fan. Project funding for building the fan is available. **Requirements:** Heat transfer 414 Thermofluids 344 Numerical Methods 414		✓		
Impact of operational and wind effects on sCO2 air-cooled heat exchanger cooling fan performance Co-supervision with Prof JP Pretorius Python sCO2-side model, co-sim with actuated disk fan model (with updates from Adam's work). Investigate effect of winds on fan and ACHE performance, investigate effect of multi-fan interactions, hot air recirculation and fan outage on ACHE performance.		✓		✓

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Requirements: Numerical fluids 414				
Improving the performance of a solarised micro gas turbine The performance of an existing micro gas turbine needs to be improved. A New impeller and diffuser has been design for the gas generator component and needs to be manufactured and tested on the gas turbine. The power turbine has to be replaced with a smaller, more realistically sized unit and a concept for an actual generator has to be developed. The system was developed to originally operated under solarised conditions but is currently being converted for research on hydrogen combustion. This work will be done in conjunction with the PhD student currently working on the system. **Requirements:** CFD, good CAD skills		✓		