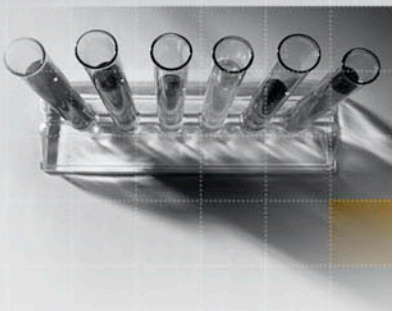
FAKULTEIT INGENIEURSWESE
FACULTY OF ENGINEERING

DEPARTMENT OF MECHANICAL AND MECHATRONIC ENGINEERING

Stellenbosch University



TOPICS 2019

PhD & MEng

(August 2018)

PhD
(Engineering)

MEng Research
(Mechanical & Mechatronic Engineering)

MEng Structured
(Mechanical Engineering)

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Design & Mechatronics

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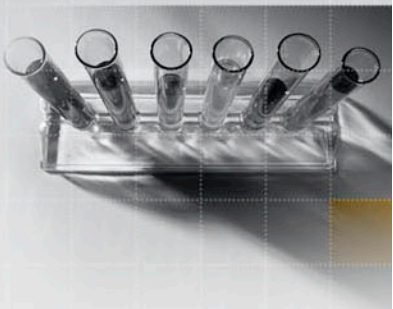

FAKULTEIT INGENIEURSWESE
FACULTY OF ENGINEERING

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Lecturer: Prof Anton Basson Dr Karel Kruger	**Email:**	ahb@sun.ac.za ; kkruger@sun.ac.za
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	Office:	A214 / A601
Faculty: Engineering	***Department:*** Mechanical and Mechatronic Engineering	

Division:
Design & Mechatronics / Mechanics / Thermo Fluids / Renewable Energy

Research field:
Manufacturing Automation for Cyber-Physical Production Systems and Industry 4.0

General description of research field:

Industry 4.0, or the fourth industrial revolution, is the current trend of automation and data exchange in manufacturing technologies. It includes cyber-physical production systems (CPPS), the Internet of things and cloud computing. Our research focusses on three levels of CPPS: (1) In the "Smart Connection Level", issues such as tether-free communication and sensor networks are considered. (2) The "Data-to-Information Conversion Level" considers issues such as smart analytics for component machine health and degradation and performance prediction. (3) The "Cyber Level" considers issues such as the twin model (or digital twin) for components and machines, machine time-variation identification and memory and data clustering for data mining.
We are also considering the role of humans, both as workers and supervisors, within modern manufacturing environments. We are interested in the adaptation of control architectures and the use of technology (e.g. wearable eye-tracking systems) to facilitate the integration of humans in manufacturing systems.

List of topics:	***MEng (Structured)***	***MEng (Research)***	**PhD**	**Funding**
1. Technologies for implementing a "digital twin" in a CPPS. This includes modelling techniques for the physical system's behaviour in the digital world, methods and formats for information exchange between the digital and physical systems, as well as between the digital twin and the cyber-space.		**X**	**X**	**1xMEng**
2. The development of an Erlang-based framework to facilitate control implementation in CPPS. Erlang is a functional programming language that offers advantages in modularity, concurrency and fault tolerance – all of which are important in various levels of CPPS.		**X**	**X**	
3. The integration of eye-tracking technology in manufacturing environments. In manual or semi-automated manufacturing systems, eye-tracking can potentially be used for quality assurance, process and workspace optimization and safety monitoring.		**X**		

***Specific requirements*:**
Although preference is given to Mechanical and Mechatronic Engineering graduates, students from other engineering backgrounds will also be considered.

Lecturer: Prof Corné Coetzee	**Email:**	ccoetzee@sun.ac.za
	Tel:	+27 21 808 4239
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Faculty: Engineering	***Department:*** Mechanical and Mechatronic Engineering	

Division:
Design & Mechatronics / Mechanics / Thermo Fluids / Renewable Energy

Research field:
The modelling of bulk materials handling in the mining and agricultural sectors.
The improvement of fruit packaging in terms of cooling and structural strength.

General description of research field:

The Discrete Element Method (DEM) is a numerical method used to model granular materials and industrial processes. Mining applications include the calibration of material properties as well as the modelling of typical mining processes such as the flow of ore on conveyor belts, transfer chutes and hoppers. The aim of such a study would be to optimise the process in terms of mass flow rates while limiting wear and spillage. Agricultural applications include the modelling of post-harvest fruit handling to predict damage and bruising and soil-tool interaction with the aim of improving the implements.
Packaging (plastic bags, carton boxes, etc.) is used to protect fruit during handling and transportation. However, the fruit need to be kept cooled while mechanical damage should be minimised. Boxes that are structurally strong will prevent any mechanical damage such as bruising but might prevent proper cooling of the fruit. On the other hand, a box which will allow the fruit to cool properly might not be able to prevent mechanical damage. The optimum design should be found.

List of topics:	***MEng (Structured)***	***MEng (Research)***	**PhD**	**Funding**
1. The modelling of a conveyor transfer chute using the Discrete Element Method (DEM). This will include experimental work using our unique large scale conveyor test facility, the calibration of material properties, and DEM modelling. The aim would be to determine how accurately DEM can predict the material behaviour in terms of flow rates, flow paths, build-up and blockage and loading onto the receiving conveyor belt. The research should also include the use of cohesive materials such as wet ore. Appropriate experiments should be developed to characterise these materials and this should be implemented in the DEM software.		**x**	**x**	**Possibility of funding for:** **1 x PhD** **1 x MEng**
2. The modelling of fruit packaging using the Finite Element Method (FEM). The properties of paperboard used to manufacture boxes should be measured and used in a FEM model to predict the structural strength of the box under different loading and environmental conditions such as changes in temperature, humidity and creep loading. This will include experimental laboratory and field work as well as FEM modelling.		**x**		**Possibility of funding for:** **1 x MEng**

***Specific requirements*:**
Finite Element Method where applicable.

Lecturer: Mr G Erfort	**Email:**	erfort@sun.ac.za
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Faculty: Engineering	***Department:*** Mechanical and Mechatronic Engineering	

Division:
Design & Mechatronics / Mechanics / Thermo Fluids / Renewable Energy

Research field:
Open source computational fluid dynamics

General description of research field:

Use of the open source package OpenFOAM to investigate flow around machinery related to the renewable energy field. Generating mathematical models in open source software for improvements on current designs and developing new designs in the renewable energy field. Use of surrogate modelling and optimization techniques.

List of topics:	***MEng (Structured)***	***MEng (Research)***	**PhD**	**Funding**
1. External aerodynamics with mesh deformation		**X**		
2. Implement and validate a tool for modelling vertical axis wind turbines		**X**		

***Specific requirements*:**

Lecturer: Prof PR Fourie	**Email:**	prfourie@sun.ac.za
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Faculty: Engineering	***Department:*** Mechanical and Mechatronic Engineering	

Division:
Design & Mechatronics / Mechanics / Thermo Fluids / Renewable Energy

Research field:
Biomedical Engineering

General description of research field:

Solving real world medical problems applying engineering solutions ranging from biomechanics, embedded electronics, machine learning solutions and nan-sensors.

List of topics:	***MEng (Structured)***	***MEng (Research)***	**PhD**	**Funding**
1.Neurofeedback and its effect on the prefrontal cortex		**X**		**Potential funding**
2.Intra-vascular pH, SaO2, PCO2 nano-sensor		**X**		**Potential funding**
3.Urine nano-sensor		**X**		**Potential funding**
4.A micosphere metered dose inhaler		**X**		**Potential funding**

***Specific requirements*:**

Lecturer: Mrs LC Ginsberg	**Email:**	ginsberg@sun.ac.za
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Faculty: Engineering	***Department:*** Mechanical and Mechatronic Engineering	

Division:
Design & Mechatronics / Mechanics / Thermo Fluids / Renewable Energy

Research field:
Biomedical engineering - Microcirculation flow pattern in the lymph

General description of research field:

The lymphatic system is an important biological system, with main functions of immunity and transportation of excess fluid from amongst the capillaries in the loose connective tissue into the vascular system. Much research has been conducted on the flow patterns of the circulatory system, into which the lymphatic system flows, however little has been attempted on the lymphatic system.

Parametric studies and numerical modelling of the micro-circulation of specific regions of the lymphatic system need to be conducted. The project takes place in the context on on-going final year projects and a PhD study.

List of topics:	***MEng (Structured)***	***MEng (Research)***	**PhD**	**Funding**
1. CFD studies of detail micro-circulation in a lymphatic segment / duct		**X**		**1 student**
2. Studies in micro flow of the lymphatic network system		**X**		**1 student**

***Specific requirements*:**
CFD

Lecturer: Prof Nawaz Mahomed	**Email:**	nawaz@sun.ac.za
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Faculty: Engineering	***Department:*** Mechanical and Mechatronic Engineering	

Division:
Design & Mechatronics / Mechanics / Thermo Fluids / Renewable Energy

Research field:
Solidification of Metal Alloys (Metal Casting)

General description of research field:

Modelling, simulation and verification of processes related to sand casting of metal alloys, which include component and mould design optimisation, solidification analysis, process simulation, analysis of microsegregation and phase transformations, analysis of porosity and surface defects, and post-cast heat treatment analysis. Use of casting simulation and phase transformation software, scanning electron microscopy (SEM) and EDS; X-ray CT for porosity inspection, heat treatment furnaces, tensile and hardness testing equipment, etc. Focus on industrial problems.

List of topics:	***MEng (Structured)***	***MEng (Research)***	**PhD**	**Funding**
1. **Effect of High-Temperature exposure on Microstructural Evolution of alloyed steels used in high performance castings.** Various high alloyed steels, such as C12A A217, are used in industrial applications in which the materials are subjected to high temperatures up to 600°C. These include thermal power plants (fossil and nuclear) and petrochemical plants. During operation at these elevated temperatures, the materials undergo microstructural changes which compromise their original strength and corrosion resistance properties. This project involves: Design, modelling and simulation of metal casting processes; prediction of microstructural evolution using Therma-Calc; heat-exposure experiments using both a temperature-controlled stage micro-furnace and a normal furnace; microstructural analysis of as-cast and heat-exposed steel samples using SEM and EDS; and the experimental analysis of tensile strength and hardness properties.		**X**		NRF Bursary of R40K for 2019 and 2020 – only for SA citizen. Student will need to obtain additional funding independently.
2. **Porosity prediction in steel castings.** Main objective: Develop an optimisation theory to minimise porosity. This could involve maximising the pressure gradient relating to the thermal characteristics (thermal gradient G at the interface, heat dissipation, and velocity of the solidification front). This will allow the control of casting processes to minimise porosity. Involves relationships for permeability and liquid fraction across the mushy zone, as well as microsegregation models to relate temperature to liquid fraction. Experimental verification. Design of experimental procedure to cast samples for testing (in accordance with the ASTM standards on porosity). Experimental			**X**	

castings. X-ray CT analysis of castings to quantify porosity severity levels.				
3. **New method for porosity measurement based on a porosity density parameter.** Study theory behind micro- and macro-porosity formation in castings. Develop a model to study the effect of solidification rate on macro-porosity formation. - Design of suitable experimental setup for experimental sand castings: controlled solidification rate. - Casting simulations (effect of solidification rate on porosity formation) - Experimental castings - Radiographic imaging for porosity evaluation – X-ray (conventional and Computed Tomography). - ASTM standards for porosity measurement. - Image processing. - Porosity density parameter measurements.		**X**		
***Specific requirements*:** Undergraduate courses in Solid Mechanics (Strengths of Materials), Fluid Mechanics, Heat Transfer and Finite Element Analysis. Interest in Materials Science / Metallurgy.				

Lecturer: Dr J Muiyser	**Email:**	jmuiyser@sun.ac.za
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Faculty: Engineering	***Department:*** Mechanical and Mechatronic Engineering	

Division:
Design & Mechatronics / Mechanics / Thermo Fluids / Renewable Energy

Research field:
Dynamics and vibration

General description of research field:

Air-cooled condenser (ACC) fans operate under distorted inlet air flow conditions due to environmental conditions as well as the presence of surrounding fans. These inlet conditions lead to elevated levels of fan vibration and reduced performance. Novel wind mitigation mechanisms have been suggested and need to be investigated.

Virtual sensors are used to predict physical parameters that are not possible to measure directly by combining measurements, physics-based simulations and machine learning. Possible applications include load and performance predictions.

List of topics:	***MEng (Structured)***	***MEng (Research)***	**PhD**	**Funding**
1. Development of a novel wind mitigation mechanism for ACC fans		**X**		**1xMEng**
2. Implementation of novel sensor technology on the SA Agulhas II		**X**		**1xMEng**
3. Development of a virtual sensor for an ACC fan based on blade load measurement		**X**		**1xMEng**

***Specific requirements*:**

Lecturer: Dr JH Müller	**Email:**	cobusmul@sun.ac.za
	Tel:	+27 21 808 4074
	Office:	Vyfster
Faculty: Engineering	***Department:*** Mechanical and Mechatronic Engineering	

Division:
Design & Mechatronics / Mechanics / Thermo Fluids / Renewable Energy

Research field:
Biomedical Engineering

General description of research field:

Biomedical engineers analyse biological systems using engineering and scientific principles. It is a true interdisciplinary research field that combines and generates new knowledge in the fields of medical, biological, clinical, engineering and quantitative sciences.
The Biomedical Engineering Research Group has several focus areas, one being computational biomechanics. Computational biomechanics implies the formulation of mathematical models that simulate the mechanical behaviour of a biological system. It relies on numerical methods to solve the mathematical equations, and experimental data to validate and verify the mathematical model predictions.

List of topics:	***MEng (Structured)***	***MEng (Research)***	**PhD**	**Funding**
1. Measurement of tendon forces during treadmill running.		**X**		**1 MEng**
2. Development of a computational workflow for heart valve development.		**X**		**1 MEng**
3. Development of a cartilage material law for a concurrent simulation workflow.		**X**	**X**	**1 MEng** **1 PhD**
4. Development of a ligament material law for a concurrent simulation workflow.		**X**	**X**	**1 MEng** **1 PhD**

***Specific requirements*:**

Sound programming skills in Python and Matlab / Finite element analysis / Computational fluid dynamics

Lecturer: Prof M Nieuwoudt	**Email:**	mnieuwoudt@sun.ac.za
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Faculty: Engineering	***Department:*** Mechanical and Mechatronic Engineering	

Division:
Design & Mechatronics / Mechanics / Thermo Fluids / Renewable Energy

Research field:
Machine Learning for Medical Imaging

General description of research field:

Tuberculosis (TB) causes complex and widespread pathology, which is challenging to segment and quantify in a reproducible manner. There is a growing interest to use PET/CT for monitoring TB treatment response and thus a need for a recognised method to quantify the images. The observed intensity of ^{18}F-fluorodeoxyglucose (FDG) Positron Emission Tomography (PET) uptake in lung lesions varies greatly. There are multiple methods to segment lesions and quantify the metabolically active lesions, but no gold standard is recognised. Density measured on Computerised Tomography (CT) is less variable, but only a small number of studies describe the automated segmentation and densometric quantification of lesions on CT. Automated mapping of lungs and recognition of different lesion-types is challenging due to the complex morphology associated with TB lesions. Machine learning techniques are well suited to this application.

List of topics:	***MEng (Structured)***	***MEng (Research)***	**PhD**	**Funding**
1. Machine Learning for co-registered CT-PET scans for identification of TB lesions in lungs		**X**		**TBA**

***Specific requirements*:**

Lecturer: Prof M Nieuwoudt	**Email:**	mnieuwoudt@sun.ac.za
	Tel:	+27 21 808 9040
	Office:	M609
Faculty: Engineering	***Department:*** Mechanical and Mechatronic Engineering	

Division:
Design & Mechatronics / Mechanics / Thermo Fluids / Renewable Energy

Research field:
Microfluidics

General description of research field:

Despite recent data indicating a worldwide decline in tuberculosis (TB) incidence, the disease continues to present serious public health challenges. Drug resistance development contributes to the extent of the epidemic and further complicates treatment. Diagnosis of TB is a slow process and drug susceptibility testing is heavily dependent on culture. In addition, TB requires very long and complex treatment regimens to achieve complete sterilisation of *Mycobacterium tuberculosis* infections. The amount of genetic material within a site of TB disease is often small, posing a challenge to the genetic detection of the causative agent of disease. The advancement in single-cell genomics brought the study of genomes to the cellular level and this field is advancing rapidly by generating many novel insights into complex biological systems. The field of microfluidics offers revolutionary capabilities for the manipulation of biological fluids containing very few cells that can serve as a front end to single cell omic technology. In this project, we will develop novel microfluidics-based cell fractionation methods and combine these with near-single cell omic technologies (specifically whole genome sequencing and RNAseq) to enhance the diagnosis of the full spectrum of drug resistance in clinical specimens from TB patients as well as to address critical knowledge gaps on the physiology of drug induced drug tolerance leading to persistent disease and associated lengthy treatment.

List of topics:	***MEng (Structured)***	***MEng (Research)***	**PhD**	**Funding**
1. Development of a microfluidic device for the isolation of bacteria from body fluids		**X**		**TBA**

***Specific requirements*:**

Lecturer: Prof K Schreve	**Email:**	kschreve@sun.ac.za
	Tel:	+27 21 808 4091
	Office:	M520
Faculty: Engineering	***Department:*** Mechanical and Mechatronic Engineering	

Division:
Design & Mechatronics / Mechanics / Thermo Fluids / Renewable Energy

Research field:
Robot navigation & metrology.

General description of research field:

Motion analysis of athletes with stationary cameras such as the Vicon system does not allow tracking athletes in large scale outdoor environments. Understanding the complex motions involved in disciplines such as mountain biking requires new technologies. With Dr's Smit and Müller, we propose to develop a mobile system relying on UAV-borne camera tracking of a mountain biker on an actual track. This part of the project is about accurately locating the UAV (or robot) so that certain markers on the biker can be tracked at high precision. This project is in collaboration with Dr's Smit and Müller who are respectively looking at the UAV control and body model aspects.

Micro-metrology and optical metrology are exciting new measurement techniques being used more and more by industry. We are busy with various metrology projects, in close collaboration with industry partners. Optical metrology has wide application: manufacturing, quality control, robotics, navigation, medicine, etc. Our focus is on precision. Micro-metrology is an emerging field of high precision measurement with many exciting high technology applications.

List of topics:	***MEng (Structured)***	***MEng (Research)***	**PhD**	**Funding**
1. High precision dimensional metrology		**X**	**X**	**Apply through CSIR/DST before 28 Sept.**
2. Constraining the SLAM feature tracking algorithm with the body model		**X**	**X**	**NRF funding**
3. Quantifying the impact of the sensor capabilities on the UAV localisation		**X**	**X**	**NRF funding**
4. Finding an optimal sensor array to achieve the required marker localisation accuracy		**X**	**X**	**NRF funding**
5. Optical metrology		**X**	**X**	**Apply through CSIR/DST before 28 Sept.**

***Specific requirements*:**

Lecturer: Dr Willie Smit	**Email:**	wjsmit@sun.ac.za
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Faculty: Engineering	***Department:*** Mechanical and Mechatronic Engineering	

Division:
Design & Mechatronics / Mechanics / Thermo Fluids / Renewable Energy

Research field:
Robotics and Control Systems

General description of research field:

Concentrated solar power (CSP) plants are a relatively new technology that promises to provide renewable energy on demand. We are investigating uses of multicopters to service CSP plants, such as cleaning the mirrors, measuring the optical characteristics of mirrors and calibrating the heliostats.

Our past multicopter research aimed to improve: the control performance of multicopters; the accuracy with which multicopters estimate position; the awareness a multicopter has of its environment.

List of topics:	***MEng (Structured)***	***MEng (Research)***	**PhD**	**Funding**
1. Investigate the viability of using a drone for deflectometry.		**X**	**X**	
2. Design a robot to clean the surface of a heliostat.		**X**		
3. Investigate the practical challenges of calibrating a heliostat with drones.		**X**		

***Specific requirements*:**

Lecturer: Dr DJ van den Heever	**Email:**	dawie@sun.ac.za
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Faculty: Engineering	***Department:*** Mechanical and Mechatronic Engineering	

Division:
Design & Mechatronics / Mechanics / Thermo Fluids / Renewable Energy

Research field:
Biomedical Engineering: Neuroscience

General description of research field:

Unlocking the mysteries of the brain is the next frontier in scientific discovery. The brain is the most complex organ in the human body (arguably in the whole universe) and is responsible for our every thought, action, memory, feeling and subjective experience. Better insights into how this all manifests is necessary for a large number of varied reasons. Neuroscientific discoveries have the potential to pioneer novel ways to treat brain diseases, improve quality of life and even revolutionize current computing technologies. Our understanding of the brain is still riddled with puzzles that cannot be considered in isolation, and therefore our focus is to link the biology of the brain to its applied philosophy.

Within my research group we aim to answer fundamental questions regarding free will and consciousness; develop low cost brain screening/assessment devices; and look into machine learning and machine consciousness for general AI.

List of topics:	***MEng (Structured)***	***MEng (Research)***	**PhD**	**Funding**
1. Solving the timing issue in the Libet studies – When does the conscious intent to move arise?		**X**	**X**	**0**
2. Low cost EEG system for brain development assessment		**X**	**X**	**0**
3. Machine learning and robots		**X**	**X**	**0**

***Specific requirements*:**

Lecturer: Dr J van der Merwe	**Email:**	jovdmerwe@sun.ac.za
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Faculty: Engineering	***Department:*** Mechanical and Mechatronic Engineering	

Division:
Design & Mechatronics / Mechanics / Thermo Fluids / Renewable Energy

Research field:
Biomedical engineering

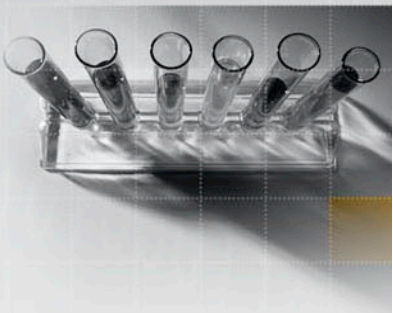
General description of research field:

Biomedical engineering with specific application to orthopaedics.

List of topics:	***MEng (Structured)***	***MEng (Research)***	**PhD**	**Funding**
1. The feasibility of using additive manufacturing for patient-specific knee replacements		**X**		**NA**
2. Finite element analysis and parameter optimisation for patient-specific knee replacements		**X**		**NA**

***Specific requirements*:**

Mechanics Division



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Lecturer: Prof TH Becker	**Email:**	tbecker@sun.ac.za
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Faculty: Engineering	***Department:*** Mechanical and Mechatronic Engineering	

Division:
Design & Mechatronics / Mechanics / Thermo fluids / Renewable Energy

Research field:
Materials Engineering

General description of research field:
The Materials Engineering group focuses on investigating the material behaviour with the aim to understand material properties and property degradation mechanisms.

We focus on:

- Develop numerical-experimental techniques.
- Linking manufacturing processes to material performance and structural integrity .
- Develop material models for predictive capabilities.
- Material characterisation and analysis.

www.sun.ac.za/mateng

List of topics:	***MEng (Structured)***	***MEng (Research)***	**PhD**	**Funding**
1. The rising demand for electrical energy in South Africa has forced suppliers to exceed the designed lifetime of existing power plants. Exceeding this design lifetime can have detrimental effects on the plant's reliability. Plant reliability is critically dependent on the integrity of a broad range of materials that make up the structures, machines and systems within the plant. It is necessary to accurately characterise the material condition with regards to the damage level, as well as to understand the damage mechanisms and subsequently to predict the damage that occurs during exposure to operating conditions, and the loss in design properties.		**x**	**x**	**1x PhD**
2. One of the concerns when utilising 3D printing technologies are their achievable mechanical properties. To date, various studies have investigated the material performance of 3D printed metals, however, what makes investigations intricate is that the material performance depends on numerous factors. The technological requirements within the context of achievable material performance are often application specific.		**x**	**x**	**1x MEng** **1x PhD**

***Specific requirements*:**
Matlab, finite element method, laboratory work at UCT, NMMU and/or aboard.

Lecturer: Prof Annie Bekker	**Email:**	annieb@sun.ac.za
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Faculty: Engineering	***Department:*** Mechanical and Mechatronic Engineering	

Division:
Design & Mechatronics / Mechanics / Thermo fluids / Renewable Energy

Research field:
Digital twin solutions and data analytic for dynamic responses of ice-going ships

General description of research field:

The SA Agulhas II is a polar supply and research vessel, which undertakes annual scientific and supply voyages to Antarctica and the South Sea Islands. She is scientifically instrumented for full-scale engineering measurements of operational parameters, ice loads, shaft-line strain and vibration. The focus is now to use these operational measurements for their predictive and decision-aiding potential. Measurements will be combined with engineering models (statistical, physics-based, machine learning, etc.) to explore digital twin solutions for shipping and polar science. Work on this project is highly international and comprises collaborations and possible exchanges with Norwegian, Finnish and German research partners.

List of topics:	***MEng (Structured)***	***MEng (Research)***	**PhD**	**Funding**
1. Full-scale and model scale analysis of ship slamming.		**X**	**X**	R70k / R100k
2. The investigation of rigid body motion as a predictor of wave state.		**X**	**X**	R70k / R100k
3. The investigation of rigid body motion as a predictor of motion sickness.		**X**		R70k
4. Structural dynamics of model-scale ships.		**X**	**X**	R70k / R100k
5. A multi-sensor decision aiding system for safe ship navigation in ice.		**X**	**X**	R70k / R100k

***Specific requirements*:**

Students participating in this project must be self-driven, willing to spend time at sea and eager to break new ground in engineering science. The success of these projects are directly related to students' willingness to take initiative, find solutions through networking and independent reading ability.

Lecturer: Prof Deborah Blaine	**Email:**	dcblaine@sun.ac.za
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	Office:	M521
Faculty: Engineering	***Department:*** Mechanical and Mechatronic Engineering	

Division:
Design & Mechatronics / Mechanics / Thermo fluids / Renewable Energy

Research field:
Mechanical behaviour of materials, powder metallurgy, sintering

General description of research field:

My research projects typically investigate the link between processing, properties and microstructures. I focus specifically on powder metallurgy and sintering, but also explore other manufacturing processes if the opportunity arises through funded projects. The research spans experimental work that uses presses, furnaces, various microscopes, mechanical testing and sometimes computed tomography. There is also scope for finite element modelling and constitutive modelling of mechanical behaviour through co-supervised projects. I collaborate with various national and international universities and research institutions on projects.

List of topics:	***MEng (Structured)***	***MEng (Research)***	**PhD**	**Funding**
1. Hybrid machining-powder metallurgy processing of titanium alloys		**X**	**X**	**1 x MEng bursary available.** **Additional MEng/PhD bursaries available - apply to DST Ti-CoC (competitive bursaries)**
2. Ultra-strong materials: MAX phase composites, nanomaterials, gel-casting of titanium alloys		**X**	**X**	**MEng/PhD bursaries available - apply to WITS CoE in Strong Materials (competitive bursaries)**
3. Additive manufacturing: novel powder blends		**X**	**X**	**1 x MEng bursary available** **(in collaboration with Boeing & National Aerospace Centre at WITS)**

Spesifieke voorvereistes / *Specific requirements*:

Lecturer: Prof Albert Groenwold	**Email:**	albertg@sun.ac.za
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	Office:	M605
Faculty: Engineering	***Department:*** Mechanical and Mechatronic Engineering	

Division:
Design & Mechatronics / Mechanics / Thermo Fluids / Renewable Energy

Research fields:
Numerical optimization, Artificial Intelligence (AI), Numerical modelling, Computing on the CPU and GPU, topology optimization.

General description of research field:
We are interested in the development and application of algorithms for general problems that are problematic in classical optimization, due to, for example, multimodality, discontinuities, etc. In particular, we are interested in very large scale (VLS) optimal design. Typically, hundreds of thousands design variables and constraints may be present. In addition, we are interested in artificial intelligence (AI), using for example particle swarm optimization (PSO) algorithms, differential evolution (DE) and genetic algorithms (GAs), etc.

Typical areas of interest (applications) include structural and multidisciplinary optimization, aspects of renewable or sustainable energy, composite materials, optimal heliostat and wind farm lay-out, and many more. However, we are not only interested in applying the algorithms we use, but also in the fundamental math that is used to formulate these algorithms, with the aim of improving performance.

An overview of my research is available here.

List of topics:	***MEng (Structured)***	***MEng (Research)***	**PhD**	**Funding**
1. Mathematical modelling and optimization – various topics, ranging from mathematical algorithmic intricacies to practical, real-world applications.		**x**	**x**	**TBC**
2. Artificial Intelligence - again, various topics, ranging from mathematical algorithmic intricacies to practical, real-world applications.		**x**	**x**	**TBC**

***Specific requirements*:** Knowledge of some computing language, and a sound mathematical background. However, not all topics require mathematicians, nor fear!

Lecturer: Prof G Venter	**Email:**	gventer@sun.ac.za
	Tel:	+27 21 808 3560
	Office:	M526
Faculty: Engineering	***Department:*** Mechanical and Mechatronic Engineering	

Division:
Design & Mechatronics / Mechanics / Thermo Fluids / Renewable Energy

Research field:
Computational mechanics

General description of research field:

Most of my research involves finite element analysis and/or numerical design optimization. This includes related technologies like design of experiments, high performance computing, meta-modelling, etc. Most of my research projects are motivated or influenced by real problems from industry, often with industry funding and concentrate on the application of the above technologies to new and interesting problems.

List of topics:	***MEng (Structured)***	***MEng (Research)***	**PhD**	**Funding**
I do not have any specific topics at the moment and my available topics typically change very quickly. If you are interested in the above mentioned research fields, you are welcome to come and meet with me to hear what is available. You are also welcome to discussing the formulation of your own topic in the above research areas with me.		**X**	**X**	**Most of my students have either full or partial funding, depending on the project.**

***Specific requirements*:**
Must be interested in structural analysis and must be willing to program (typically in Python).

Lecturer: Dr MP Venter	**Email:**	mpventer@sun.ac.za
	Tel:	+27 21 808 4477
	Office:	M528

Faculty: Engineering	***Department:*** Mechanical and Mechatronic Engineering

Division:
Design & Mechatronics / Mechanics / Thermo Fluids / Renewable Energy

Research field:
Inflatables

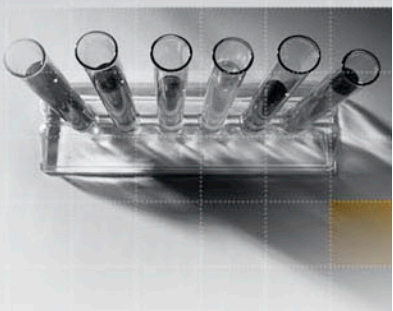
General description of research field:

Loosely defined the field of inflatables refers to any technology that makes use of a pressurised fluid to maintain its structure, or is the mechanism of energy transfer in locomotion. I am investigating two interesting applications of inflatables, inflatable morphable wings and soft robots. Each of these are used as a platform for the development of the methods required to fully utilize their full design domain. This includes simulation techniques, materials characterisation, fabrication and machine learning. These are combined in the field of computational design where we make use of computational resources to assist in the exploration of a complex design space.

List of topics:	***MEng (Structured)***	***MEng (Research)***	**PhD**	**Funding**
1. Intelligent reinforcement of highly compliant silicon		**1**		**TBD**
2. Programmable elastic response in soft robots		**1**		**TBD**
3. Computational design of soft robot actuator modules		**1**		**TBD**
4. Computational design of complete soft robots using reinforcement learning		**1**	**1**	**TBD**
5. Design space exploration for soft robots using computational tools		**1**	**1**	**TBD**
6. Selectively reinforced silicon textile composites		**1**		**TBD**
7. Soft robot behaviour predictor using machine learning		**1**	**1**	**TBD**

***Specific requirements*:**
Students interested in this field of research should enjoy the challenge of an open ended project, have basic programming and simulation skills and a will to learn more.

Thermo Fluids Division



FAKULTEIT INGENIEURSWESE
FACULTY OF ENGINEERING

UNIVERSITEIT
STELLENBOSCH
UNIVERSITY

Lecturer: Dr JE Hoffmann	**Email:**	hoffmaj@sun.ac.za
	Tel:	+27 21 808 3554
	Office:	M619
Faculty: Engineering	***Department:*** Mechanical and Mechatronic Engineering	

Division:
Design & Mechatronics / Mechanics / Thermo Fluids / Renewable Energy

Research field:
Thermal Engineering

General description of research field:

The SUNSPOT cycle is a combined Brayton and Rankine cycle with thermal storage. Air is the working fluid for the Brayton cycle. Due to the poor heat transfer characteristics of air, and the high energy flux at the receiver, receiver tubes are subject to high temperatures and thermal stresses. This research focus on enhancing heat transfer inside receiver tubes, thermal radiation in cavity receivers and novice configurations for receiver designs.

List of topics:	***MEng (Structured)***	***MEng (Research)***	**PhD**	**Funding**
1. Experimental/numerical study of the effect of packing structure, particle shape and orientation on heat transfer and pressure drop in rock bed thermal energy storage.	**X**	**X**	**X**	**Pending**
2. Extend thermal non-equilibrium model in commercial CFD code to include convection and thermal radiation in porous media, and validate model against experimental data (receiver and/or rock bed storage).		**X**	**X**	**Pending**
3. Techno-economic evaluation of SUNDISC cycle using an organic Rankine bottoming cycle.	**X**	**X**		
4. Numerical modelling of flow and heat transfer in a falling particle receiver.		**X**	**X**	
5. Determining the heat transfer coefficient on the outer wall of a pipe submerged in a moving bed of particles, and identify suitable parameters to correlate it against.	**X**	**X**		

***Specific requirements*:**
Topics 2, 4 and 5 require sound CFD and C^{++} programming skills.

Lecturer: Dr M Owen	**Email:**	mikeowen@sun.ac.za
	Tel:	+27 21 808 4266
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Faculty: Engineering	***Department:*** Mechanical and Mechatronic Engineering	

Division:
Design & Mechatronics / Mechanics / Thermo Fluids / Renewable Energy

Research field:
Heat transfer, fluid dynamics, industrial heat exchangers

General description of research field:

Most of my research relates to the performance of large industrial heat exchangers. Projects will typically include a combination of experimental, analytical and numerical (CFD) analysis and are driven by requests from industry. Students will be contributing to the ongoing endeavour to optimize cooling system performance and subsequently improve energy efficiency in a number of industries but notably the power sector. The research is highly relevant to concentrating solar energy technologies as well as conventional thermal power plants.

List of topics:	***MEng (Structured)***	***MEng (Research)***	**PhD**	**Funding**
1. Investigation of dry out in deluged plain tube heat exchanger bundles		**X**		**2 (not confirmed)**
2. Investigation of critical water and air fluxes for co- and counter-current deluged tube bundles		**X**		**1 (not confirmed)**
3. Air-cooled steam condenser condition monitoring		**X**	**X**	
4. Wind effects on water surface air coolers		**X**		
5. The effect of wind screens on large air-cooled condenser performance		**X**		

***Specific requirements*:**

Lecturer: Mr MC Tshamala	**Email:**	mctshamala@sun.ac.za
	Tel:	+27 21 808 4243
	Office:	M529/A610
Faculty: Engineering	***Department:*** Mechanical and Mechatronic Engineering	

Division:
Design & Mechatronics / Mechanics / Thermo Fluids / Renewable Energy

Research field:
Water Generation/Supply Technology

General description of research field:

For a ship in deep sea, as an autonomous system, it is mandatory to effectively use the energy provided by the combustion of fuel to sustain this last for the duration of the trip. Previous research and technology developments have looked at recovering waste heat through engine cooling systems powering several on-board systems such as water desalination, and/or water heating. For this project, a flue gas heat recovery system will be investigated and the available heat recovered used as heat source for sea water desalination on the ships. A calculation model will be generated and experimental validation will be required.

List of topics:	***MEng (Structured)***	***MEng (Research)***	**PhD**	**Funding**
1. Investigation and development of a waste heat recovery for sea water desalination in marines engineering.	**X**	**X**		**Pending funding application**

***Specific requirements*:**

Lecturer: Prof SJ van der Spuy	**Email:**	sjvdspuy@sun.ac.za
	Tel:	+27 21 808 4127
	Office:	
Faculty: Engineering	***Department:*** Mechanical and Mechatronic Engineering	

Division:
Design & Mechatronics / Mechanics / Thermo Fluids / Renewable Energy

Research field:
Axial flow fans for cooling systems

General description of research field:

The use of direct dry-cooled condensers in power generation systems is a means of ensuring sustainable water usage. This makes it ideal for use in power plants (including solar power plants) which are located in regions with a limited availability of water resources. The efficient operation of the axial flow fans that form part of such an air-cooled system is essential for a well-performing cooling plant. This research focusses on the design, testing and analysis of axial flow fans for these systems.

List of topics:	***MEng (Structured)***	***MEng (Research)***	**PhD**	**Funding**
1. Experimental and numerical analysis of fan noise		**X**	**X**	**Project funding available (possible bursary)**
2. On-site measurement of installed fan performance		**X**	**X**	**Project funding available**

***Specific requirements*:**
Thermofluids 344, CFD

Lecturer: Prof TW von Backström	**Email:**	twvb@sun.ac.za
	Tel:	+27 21 808 4267
	Office:	M525
Faculty: Engineering	***Department:*** Mechanical and Mechatronic Engineering	

Division:
Design & Mechatronics / Mechanics / Thermo Fluids / Renewable Energy

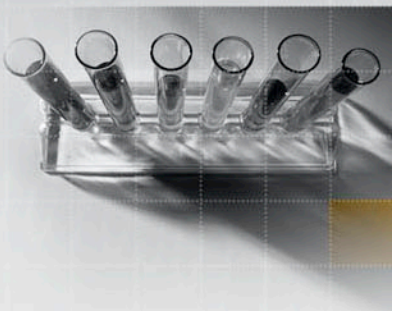
Research field:
Turbomachinery

General description of research field:
Optimal layout and design of fans and compressors.

List of topics:	***MEng (Structured)***	***MEng (Research)***	**PhD**	**Funding**
1. Investigate the performance of an axial fan with alternate long and short blades. The tip vortices if the short blades should induce more flow near the hub, thereby allowing the use of smaller fan hubs.		**X**		**0**
2. The development of an alternative one-equation model for the prediction of slip factor in centrifugal compressor rotors.	**X**	**X**		**0**

***Specific requirements*:**
The first topic is largely experimental.
The second topic requires mathematical skills relating to the solution of partial differential equations in polar coordinates.

Renewable Energy



FAKULTEIT INGENIEURSWESE
FACULTY OF ENGINEERING

UNIVERSITEIT
STELLENBOSCH
UNIVERSITY

Lecturer: Prof Albert Groenwold	**Email:**	albertg@sun.ac.za
	Tel:	+27 21 808 4028
	Office:	M605
Faculty: Engineering	***Department:*** Mechanical and Mechatronic Engineering	

Division:
Design & Mechatronics / Mechanics / Thermo Fluids / Renewable Energy

Research fields:

Numerical optimization, Artificial Intelligence (AI), Numerical modelling, Computing on the CPU and GPU, topology optimization.

General description of research field:

We are interested in the development and application of algorithms for general problems that are problematic in classical optimization, due to, for example, multimodality, discontinuities, etc. In particular, we are interested in very large scale (VLS) optimal design. Typically, hundreds of thousands design variables and constraints may be present. In addition, we are interested in artificial intelligence (AI), using for example particle swarm optimization (PSO) algorithms, differential evolution (DE) and genetic algorithms (GAs), etc.

Typical areas of interest (applications) include structural and multidisciplinary optimization, aspects of renewable or sustainable energy, composite materials, optimal heliostat and wind farm lay-out, and many more. However, we are not only interested in applying the algorithms we use, but also in the fundamental math that is used to formulate these algorithms, with the aim of improving performance.

An overview of my research is available here.

List of topics:	***MEng (Structured)***	***MEng (Research)***	**PhD**	**Funding**
1. Mathematical modelling and optimization – various topics, ranging from mathematical algorithmic intricacies to practical, real-world applications.		**x**	**x**	**TBC**
2. Artificial Intelligence - again, various topics, ranging from mathematical algorithmic intricacies to practical, real-world applications.		**x**	**x**	**TBC**

***Specific requirements*:**
Knowledge of some computing language, and a sound mathematical background. However, not all topics require mathematicians, nor fear!

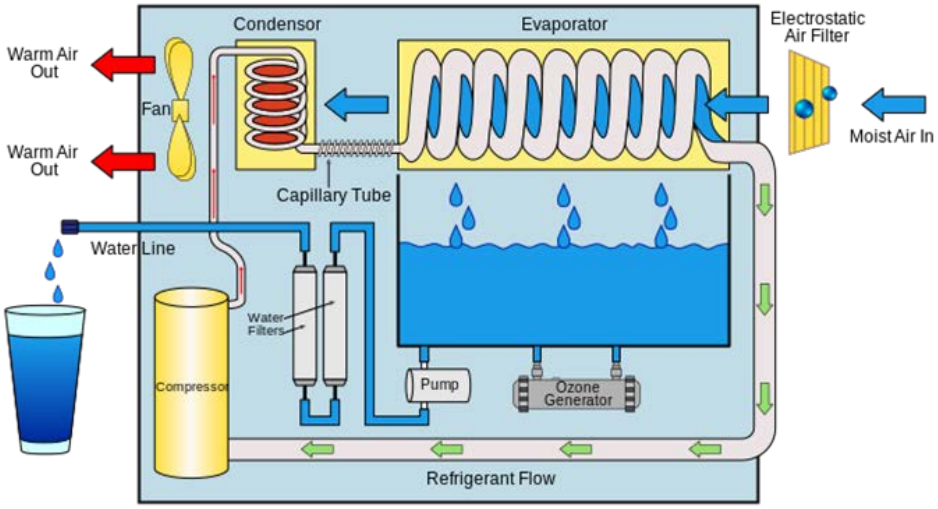
Lecturer: Mr MC Tshamala	**Email:**	mctshamala@sun.ac.za
	Tel:	+27 21 808 4243
	Office:	M529/A610
Faculty: Engineering	***Department:*** Mechanical and Mechatronic Engineering	

Division:
Design & Mechatronics / Mechanics / Thermo Fluids / Renewable Energy

Research field:
Water Generation/Supply Technology

General description of research field:

In light of the recent drought experienced in South Africa in general, it is mandatory to research for alternative energy efficient sources of drinkable water to effectively ensure water supply to public area such as parks that have been cut out of water supply. Previous research and technology developments have looked at the atmospheric air as viable source of drinkable water and have developed a number of atmospheric water generator unit designs. For this project, an absorption refrigeration cycle will be used to provide the necessary cooling for atmospheric water condensation. A calculation model is to be developed to quantify the possible recoverable amount of water in various weather conditions. Experimental validation will be considered, subject to resources availability.



List of topics:	***MEng (Structured)***	***MEng (Research)***	**PhD**	**Funding**
1. Development of calculation model and experimental validation of a solar powered absorption cycle for an atmospheric water generator.	**X**	**X**		**Pending funding application**

***Specific requirements*:**
There is possibility for 3 to 9 months exchange to the USA for the experimental component for the qualifying MEng Research student.

Lecturer: Prof TW von Backström	**Email:**	twvb@sun.ac.za
	Tel:	+27 21 808 4267
	Office:	M525
Faculty: Engineering	***Department:*** Mechanical and Mechatronic Engineering	

Division:
Design & Mechatronics / Mechanics / Thermo Fluids / Renewable Energy

Research field:

Concentrating solar power; conversion of gas turbine to run on biogas; combined cycle power plants: rock bed thermal energy storage; solar receiver optimisation.

General description of research field:

Improvement of the underlying technologies of the Stellenbosch University Solar Thermal Power Thermodynamic (SUNSPOT) cycle and the Spiky Central Receiver Air Pre-heater (SCRAP) as mentioned above.

List of topics:	***MEng (Structured)***	***MEng (Research)***	**PhD**	**Funding**
1. Modelling and CFD validation of external wind flow (air flow through spikes) and natural convection on spikes		**X**		
2. Advancement of spike tip jet impingement cooling through improved geometry		**X**	**X**	**1MEng** **1PhD**
3. Advancement of exploiting the benefits of helically swirled fins where a CFD model starts combining the environment around a spike with inside to understand and quantify the benefits.)		**X**	**X**	**1MEng** **1PhD**
4. Comparison of rock-bed TES charged from CSP technology to using PV generated heat (understanding the margin thermal is still ahead of PV).	**X**			
5. Redesign and costing of full scale rock bed thermal energy system		**X**		**1MEng**

***Specific requirements*:**