

# GET SET GO!

Career  
options in

Science,  
Engineering and  
Technology:

Worlds of  
opportunity



**SAASTA**  
South African Agency for Science  
and Technology Advancement



South African Agency for Science and Technology Advancement  
**Promoting the science of today for the world of tomorrow**

Making scientific disciplines more accessible to South Africans is crucial. This is exactly what the South African Agency for Science and Technology Advancement (SAASTA) intends to achieve.

As a business unit of the National Research Foundation (NRF), our mandate is to:

- steer young minds towards careers in science, technology and innovation;
- interact with the public on issues of science, engineering and technology; and
- communicate the advances in science and technology to the public.

Through our many outreach and awareness programmes we aim to entice students to pursue careers in science, and to instil in people an enthusiasm for and deeper understanding of the application of science in our everyday lives.

SAASTA is integrally involved in promoting science at school level. We believe that South Africa has the potential to become a rich source of scientific expertise – but only if the system is fed with a healthy supply of learners whose interest in science, engineering and technology is guided by equally passionate educators.

Please note that the acronym SET is normally used for **Science, Engineering and Technology**. Although we have not referred to SETI, this book also includes information about career opportunities in **Innovation**.

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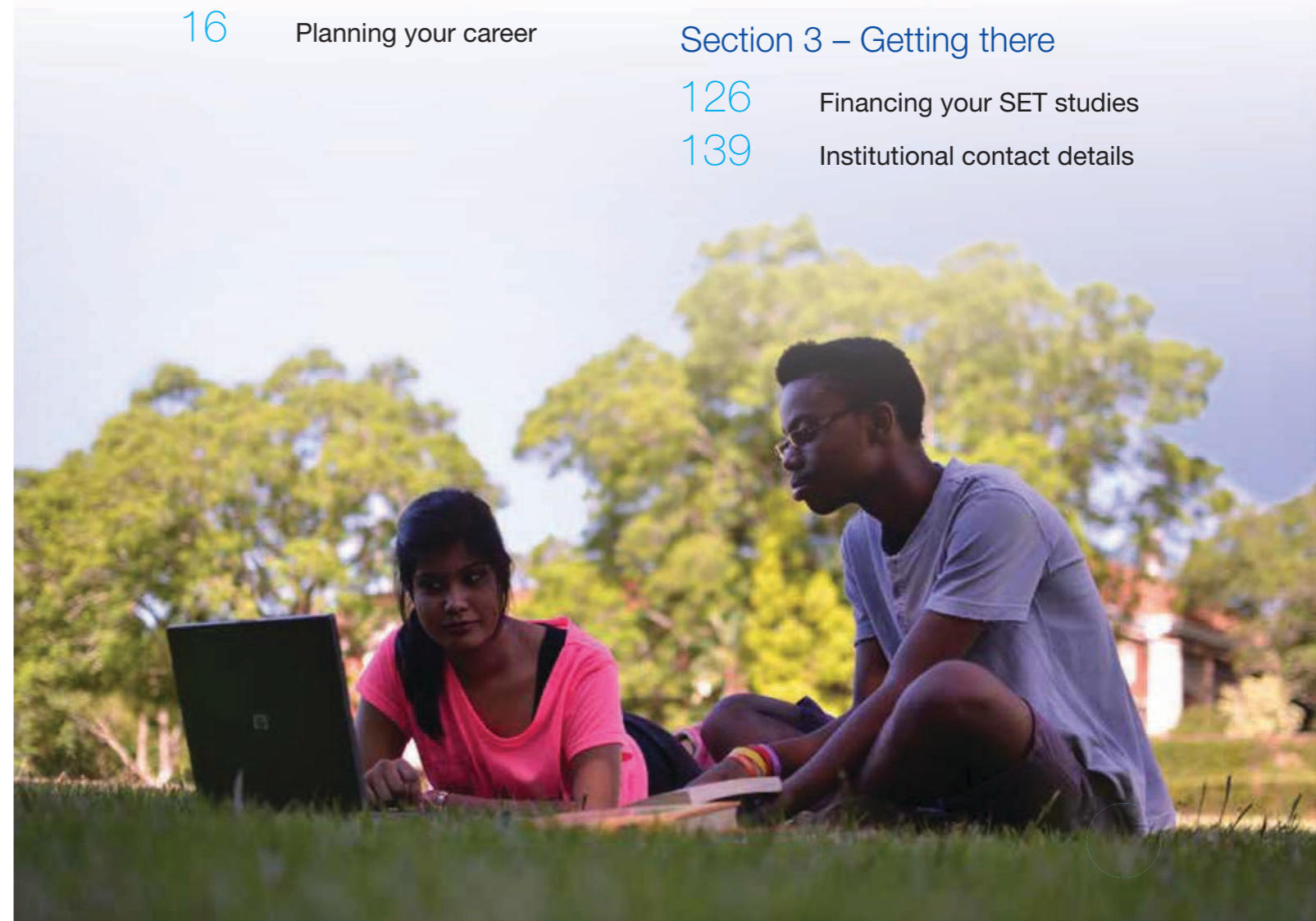
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# Foreword

Dr Jabu Nukeri, Managing Director of the South African Agency for Science and Technology Advancement (SAASTA), a business unit of the National Research Foundation

**We are living in a scientific and technological revolution which is characterised by exponential growth and accelerating change particularly in the fields of Science, Engineering, Technology and Innovation.**

The rapid advancements in Computer Science and Information Technology had brought the added need for us as a nation to seriously consider how to prepare our youth to be economically active in a society built on Information Technology rather than on industrial systems.

It is against this background that I strongly believe that a future with more jobs and prosperity, better health, fewer disadvantaged people and better protection for our fragile planet is a vision that is shared by South Africans and must be pursued. These outcomes

are not possible without Science, Engineering and Technology (SET). The applications of SET lead to new products and services that can make our world a better place for all.

South Africa needs to be self-sufficient and economically competitive and to achieve that, our country needs young people who have a passion for the critical subjects of Science, Mathematics and Technology and who excel in these subjects. What needs to be done is to prepare our youth to be effective citizens in the scientific, mathematical and technological world of which we dream.

Part of SAASTA's mandate is to steer young minds towards careers in science, engineering, technology and innovation and thus contribute towards growing the pool of a representative SET workforce in South Africa. We aim to grow both the number and competence of people qualified in science, mathematics and engineering in South Africa. This is in line with the mandate of our parent organisation, the National Research Foundation which is, in part, to support and promote research through funding, human resource development (where SAASTA fits in) and the provision of the necessary research facilities.

I believe this book will – together with our other projects such as career profiling events, STEMI Olympiads and Competitions, the educational resources we produce and



the festivals and competitions we support – assist SAASTA to fulfil that mandate. I believe that this attractive book – full of fascinating information about the scientific challenges that our country faces, the cutting-edge research that is being done to address those challenges, and the careers of inspiring researchers and engineers – will do much to open the eyes of learners to the possibilities that await them in SET careers and help them to fulfil their dreams and aspirations.

I am sure the role models featured in this book will be a source of inspiration and encourage learners to look into the possibilities of studying towards careers in science, engineering and technology. Many of them had to challenge the tide to reach their goals. I believe our young readers can do that too.

I sincerely hope that educators as well as learners will find this publication a valuable source of information; and that it will inspire many learners who are not yet sure of what they want to do with their lives to recognise that a career in SET is the one to choose.

**Dr Jabu Nukeri**



# Science, Engineering and Technology – a world of opportunity

Are you thinking about a career in science, engineering or technology? There are hundreds of SET career options out there – and the list is growing.

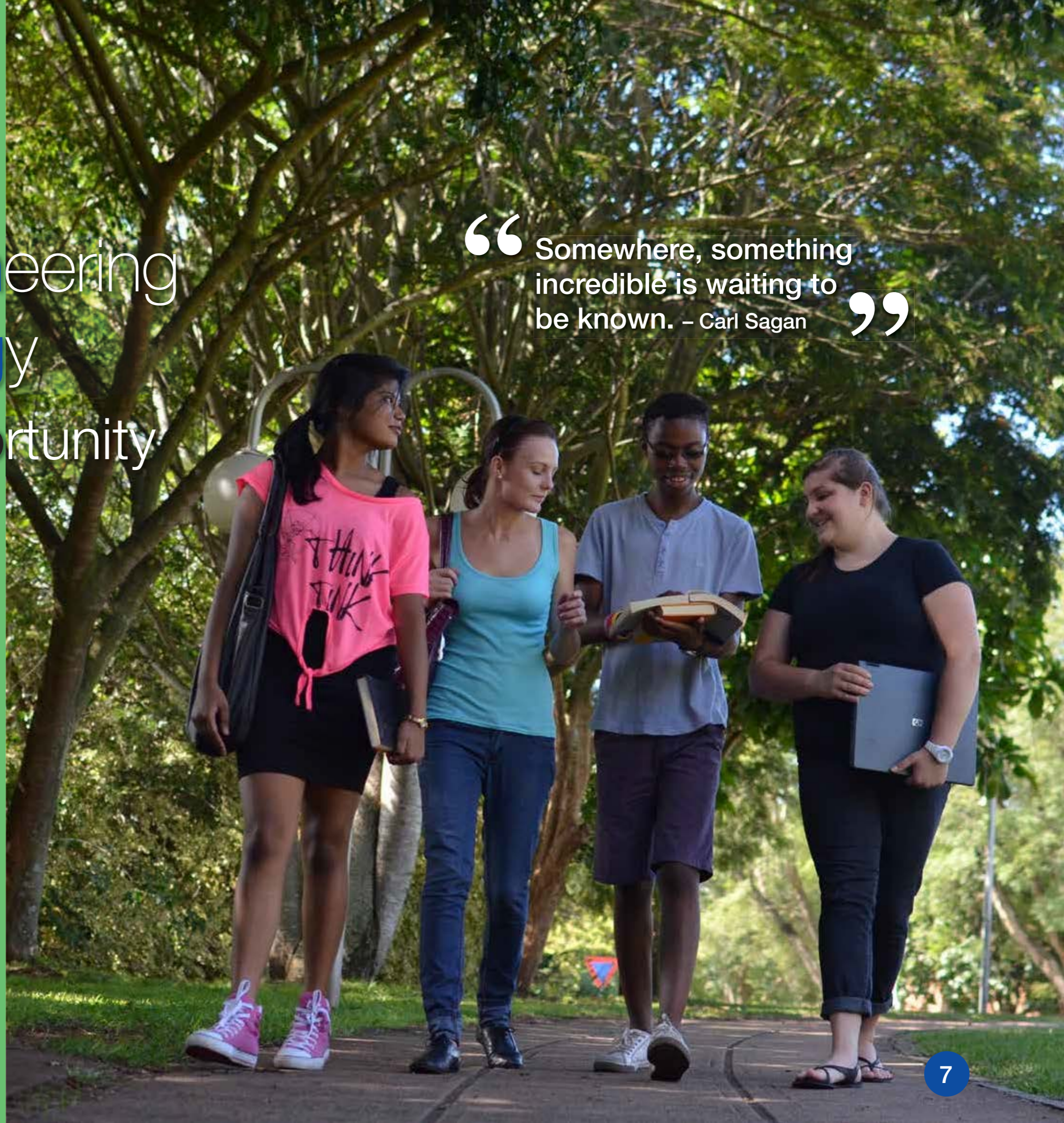
This book will help you to understand more fully the range of choices you have. It will also help you decide which path might be best for you.

Remember, you cannot make a decision without being informed.

This book will guide you through the various steps involved in making a career choice and also tell you where to get more information.

Making a career choice is one of life's more important decisions, but it's also important to keep your options open and have a backup plan – or two. We show you how.

“ Somewhere, something incredible is waiting to be known. – Carl Sagan ”



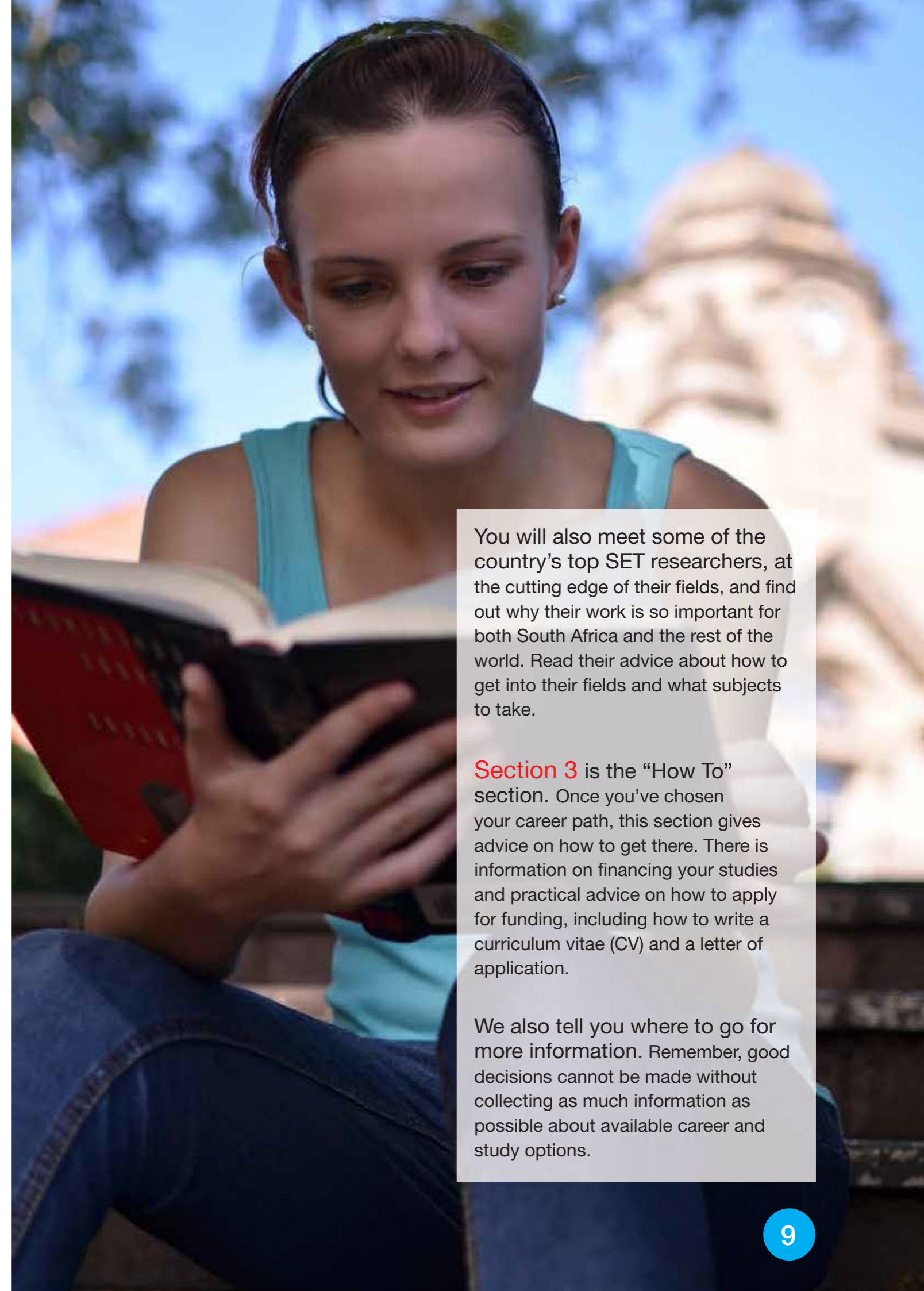


# Finding your way around this book

This book is divided into various sections, each dealing with different aspects of career planning.

**In Section 1**, we cover basic issues such as the value of a SET career, when to start planning your career, how to decide which field to pursue and choosing the right kind of institution for you. We answer some of your likely questions about the whole process of choosing a career.

**Section 2** deals with some of the important current SET subject areas. These include: biotechnology, space science & technology, energy security, climate change, hydrogen and fuel cell technology, engineering and nanotechnology. You will meet some of the people working in these fields and find out what they do and what they enjoy about their work. They will also give you advice on what academic requirements are needed to pursue a similar career and where you can study to achieve your dreams.



You will also meet some of the country's top SET researchers, at the cutting edge of their fields, and find out why their work is so important for both South Africa and the rest of the world. Read their advice about how to get into their fields and what subjects to take.

**Section 3** is the "How To" section. Once you've chosen your career path, this section gives advice on how to get there. There is information on financing your studies and practical advice on how to apply for funding, including how to write a curriculum vitae (CV) and a letter of application.

We also tell you where to go for more information. Remember, good decisions cannot be made without collecting as much information as possible about available career and study options.





# The time is right for SET

It's an exciting time for you to be thinking about a career in science, engineering and technology.

As a developing country and a relatively young new democracy, South Africa desperately needs skills to help the country compete internationally, grow economically and generally improve the lives of all its citizens.

People with skills in the science, engineering and technology sector are in relatively short supply, but they are essential to our country's progress.

For example, South Africa needs at least 30 000 additional engineers in the near future and at least 50 000 additional artisans. Information

and communication technology professionals are also needed.

Internationally, people with SET skills are also in demand. The recent rapid development of information technology and the Internet has meant that the world is constantly changing and having to adapt to new developments. SET careers are in demand and are classified as scarce skills throughout the world.

For example, it was estimated that in 2006 alone 1.5 exabytes ( $1.5 \times 10^{18}$ ) of unique new information was generated worldwide – more than all the information generated in the last 5 000 years.

“ We are currently preparing students for jobs that don't yet exist, using technologies that haven't yet been invented ... in order to solve problems we don't even know are problems yet. (www.shifthappens.wikispaces.com). ”

This development has huge implications for the world of work. It means:

- It is more important than ever that people trying to find employment in the workplace have up-to-date and relevant skills;
- There is a whole range of new jobs or careers you can consider pursuing which probably didn't even exist 10 years ago; and
- Lots of new jobs are likely to be developed during the time you are studying towards your chosen career.

For example, for students starting a four-year technical or university degree, half of what they learn in their first year of study will be outdated by their third year (www.shifthappens.wikispaces.com).



## How do you know if a SET career is right for YOU?

If you like **Physical Science and Maths**, that's a good starting point for considering a career in the SET sector.

Maths and Physical Science are required for all SET-related courses of study (see page 20 for other essential requirements).

In addition, ask yourself the following questions:

- Are you interested in how things work?
- Do you enjoy solving problems?
- Are you always asking 'why'?
- Are you fascinated with the material world?
- Do you love working with computers, machines, facts and figures more than with people?

If you answered 'yes' to most of these, then a SET career could be for you. But first, let's find out more about making career decisions.



## Key sectors of future development in South Africa

The South African government has identified a number of key areas for development which are set to create employment opportunities for people with the relevant skills. These include:

- The building of **infrastructure** for energy supply, transport, water supply and communications;
- **Agriculture and mining** – and their respective value chains: adding value to agricultural products and raw materials through processing;
- **Tourism**;
- The **Green Economy**, including construction, green infrastructure ICTs, health care and biotechnology;
- **Manufacturing**.

### Transport

Transnet, the company behind South Africa's national transport businesses, will be investing R300 billion in infrastructure over the next seven years.

These major investments will be into railways (R201 billion), harbours (R47 billion), port terminals (R33 billion), pipelines (R11 billion) and rail engineering works (R4 billion). All that development requires hundreds of skilled workers.

### The Green Economy

Environmental Affairs Minister Edna Molewa has said that the R7.7 billion budgeted for environmental programmes from now until 2015 will provide nearly 206 000 work opportunities and nearly 103 000 full-time equivalent jobs.

In her 2012 Budget vote speech, she said: **"The Green Economy offers substantial opportunities for job creation and development in the environmental goods and services sector, particularly in biodiversity, waste and natural resource management services."**

Her statements were in line with a recent Green Jobs report produced jointly by the Industrial Development Corporation and the Development Bank of Southern Africa which said there was an opportunity to create 98 000 new jobs in the short term and about 462 000 employment opportunities in the formal economy by 2025 by pursuing efforts to green the South African economy (Engineering News, 2 May 2012).

### Nuclear and other power generation

South Africa plans to generate 9.6 GW of electricity from nuclear energy by 2030 as well as 6.3 GW of new base-load coal capacity.

Energy Minister Dipuo Peters has said that job creation was central to the country's nuclear build programme. Not only would nuclear expansion create mining and construction jobs, it would also open opportunities in the field of science.



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# FAQs

## Q: When should I make a decision about my future career?

A: It is best to start early and have some idea by Grade 8.

In Grade 7 you will have been exposed to some career information during Life Orientation lessons. In Grade 8, career guidance lessons should start to help you to prepare to make some choices around careers. By Grade 9 it is important to have a clear idea of what you want to do and know about the different career fields and vocations you can follow in each field. You should also know about different tertiary institutions where you can study and funding options (including loans, bursaries and scholarships). All this information will enable you to decide which subjects to take for Grades 10-12 and will determine the courses you are allowed to study after school.

## Q: Should I choose an 'easy' subject to boost my average matric results?

A: No. Learners should focus on specific career fields and choose all their subjects in these fields to raise their chances of being accepted for admission to university or college.

## Q: Should I only choose one career option?

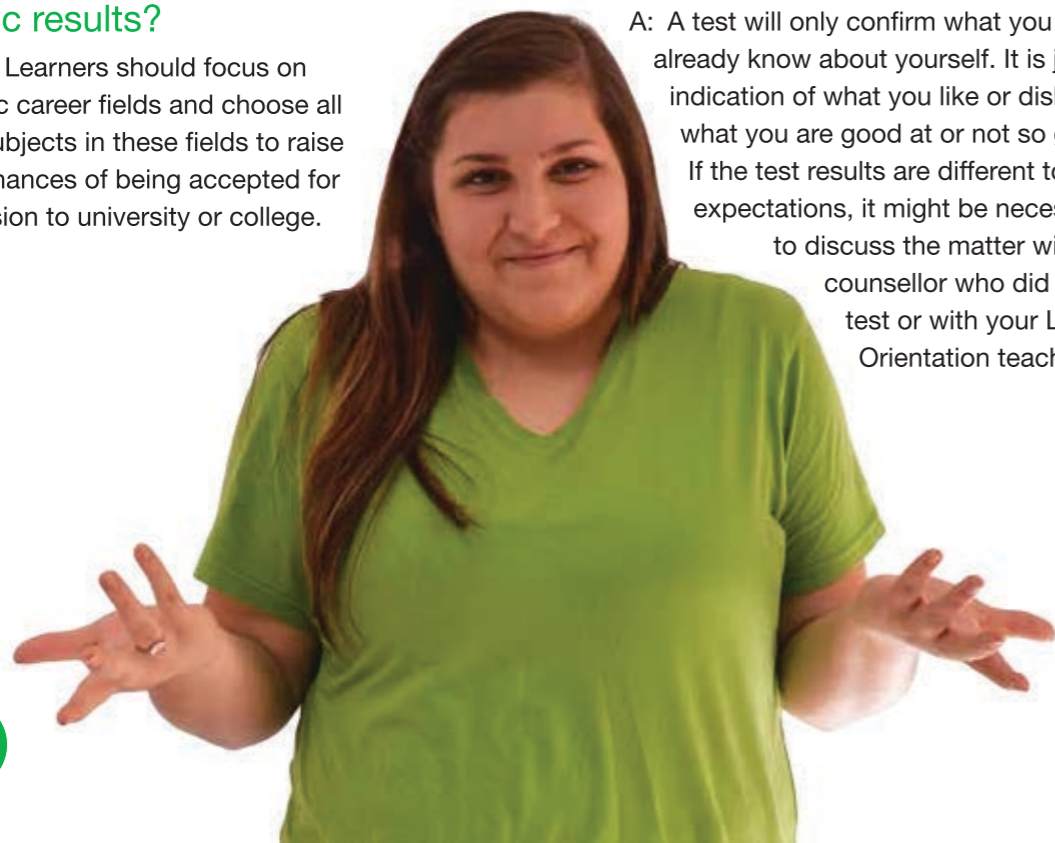
A: No. Sometimes when a learner's focus is too narrow, they are stuck when they find that they cannot for some reason pursue that path. You should have at least three possible options in case you are not accepted for your first choice of study.

## Q: Should I choose a career that will simply make my parents happy?

A: It is best to choose a career that meets your needs and interests, rather than those of your parents. Many learners who make decisions based on the expectations of others end up losing interest in their course, or find it difficult or boring, and eventually drop out.

## Q: Will a test help me decide what career would be best for me?

A: A test will only confirm what you already know about yourself. It is just an indication of what you like or dislike, what you are good at or not so good at. If the test results are different to your expectations, it might be necessary to discuss the matter with the counsellor who did the test or with your Life Orientation teacher.



# University of Johannesburg Faculty of Engineering and the Built Environment Engineering our future



## FACULTY OF ENGINEERING AND THE BUILT ENVIRONMENT

"Engineering is everywhere and can take you from the depths of the ocean to the far reaches of outer of space, from within microscopic structures of the human cell to the top of the tallest skyscrapers". Engineers, technologists and technicians all play a role in designing, creating, building and working on just about everything people touch, wear, see, hear and use in their daily lives. Engineering and the Built Environment professionals, technologists and technicians are behind almost all of today's technology and infrastructure.

Career possibilities in the field of Engineering and the Built Environment can lead to exciting and rewarding occupations. The opportunities that are available to UJ Engineering and the Built Environment graduates are tremendous. Teaching programmes ensure that students develop and enhance their understanding of the various skills needed for their profession.

We are proud to offer a full spectrum of engineering qualifications:

### SCIENCE PROGRAMMES:

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- Mechanical Engineering science
- Electrical and Electronic Engineering Science

### TECHNOLOGY PROGRAMMES:

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- Town and Regional Planning Technology
- Electrical and Electronic Engineering Technology
- Mechanical Engineering Technology
- Industrial Engineering Technology
- Engineering Metallurgy Technology
- Extraction Metallurgy Technology
- Mining Surveying Technology
- Mining Engineering Technology
- Chemical Engineering Technology
- Quality and Operations Management

### Technology Programme Queries

**Senior Faculty Officer:** Ms P Naidoo  
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### Science Programme Queries (Undergraduate)

**Senior Faculty Officer:** Ms T Mathibela  
**Telephone:** + (0)11 559 2115 | **Email:** thokom@uj.ac.za

**For more information visit our website:**  
<http://www.uj.ac.za/engineering>



# Planning your career

The path to making a decision is relatively simple, but requires you to be informed – about yourself and the various career options out there.

## 1 Knowing Yourself

One of the first steps to choosing a career is knowing who you are and what you love doing most.

This can be quite difficult for some learners. Some people think that Grade 9 learners are too young to know what they want to do, but it is also true that most of us know from an early age the activities and subjects we like and dislike. For example, some people know they would like to work with people, while others know they like to work with their hands or equipment.

Basically, it is useful to understand the following about yourself:

**Interests:** This includes the things you like to read and talk about and the things you like to do. People who do what they are interested in are usually happier in their work and are likely to have more job satisfaction.

**Strengths:** What subjects do you perform well in? In which subjects are you weakest? Although performance is not always related to ability, it can sometimes provide some indication of aptitude. Strengths can also include activities outside of the classroom.

**Characteristics and traits:** All people have unique personalities, characteristics and traits. Such qualities could include being calm, patient, competitive, shy, dominating, people-

oriented, talkative, disciplined, goal-oriented or cautious. Different careers require different characteristics and traits. When careers and personal traits coincide, people generally feel more satisfied.

### To understand more, ask yourself the following:

- Do you think with your heart or your head?
- Do you work accurately and check your own work for errors?
- Do you prefer working alone or in a group?
- Do you study consistently hard during the whole year?
- Are you curious and ask lots of questions?

Generally, the qualities most suited to an individual pursuing a SET career are:

- The ability to work independently
- A thirst for knowledge and being clever
- Goal orientation and ambition
- The application of logic to thinking and decision-making.

**Values:** Do you value money above everything else or are you more interested in service to others? These kinds of questions help you to understand your values – those personal beliefs according to which you choose to live your life. These qualities can also affect your choice of career.

After you’ve done some soul-searching about yourself, the next step is to understand all the SET career options available to you.

## 2 Learning about Careers

Careers are categorised according to fields of interest with a number of sub-fields. Universities and colleges have different faculties or schools for each field and sub-field. The fields are broadly as follows:

Career field	Career sub-fields
Science, Engineering and Technology fields (SET)	<ul style="list-style-type: none"> <li>• Geosciences (geology, geochemistry)</li> <li>• Physical and Chemical Sciences (physics, chemistry)</li> <li>• Biological Sciences (botany, zoology, microbiology)</li> <li>• Engineering Science (civil, mechanical, chemical, aeronautical, and more)</li> <li>• Built Environment (architecture, urban and regional planning)</li> <li>• Health Science (medicine, nursing, paramedical, pharmacy)</li> <li>• Computer Science (programming)</li> <li>• Mathematical Science (actuarial science, mathematics, statistics)</li> </ul>
Environmental and Agricultural Science	<ul style="list-style-type: none"> <li>• Environmental (environmentalist, forestry, game ranging)</li> <li>• Agriculture (farming, irrigation, animal production, animal science, soil science, crop science)</li> </ul>
Economic and Management Science	<ul style="list-style-type: none"> <li>• Business and Commerce (accounting, auditing, economics)</li> <li>• Management degrees (human resources, marketing, logistics, hospitality, public administration, sport management)</li> </ul>
Human Science	<ul style="list-style-type: none"> <li>• Human Sciences (psychology, sociology, social work, history, languages, communication, criminology)</li> </ul>
Arts and Design	<ul style="list-style-type: none"> <li>• Visual and Performance Arts (sculptors, artists, dancers)</li> <li>• Design (graphic, interior)</li> </ul>
Law	<ul style="list-style-type: none"> <li>• Law degrees</li> <li>• Security service qualifications</li> <li>• Legal secretary</li> </ul>
Theology	<ul style="list-style-type: none"> <li>• Theology qualifications</li> </ul>
Education	<ul style="list-style-type: none"> <li>• Education qualifications (early childhood, foundational, intermediate, senior phase, FET phase, higher education)</li> </ul>

People who work in each of the above fields possess certain interests, strengths, characteristics/traits, and values which make them suited to their careers.

Most SET fields call for an interest and skill in Mathematics.



**Q: What’s the difference between a career field, a sub-field, a vocation and a job?**

A career field is a broad category of vocations and occupations that have a similar scientific origin, for example, Engineering. This career field has sub-fields which include civil, mechanical, electrical, chemical engineering, etc. A vocation describes a profession or ‘calling’, while a job or occupation refers to the specific work a person does, for example, an engineering technologist. Understanding all these categories is important when making a career-related decision.

Career field	Career sub-fields	Occupation/job
Engineering Science	Engineering	Engineer, Engineering Technologist, Engineering Technician
Educational Science	Education or Teaching	Teacher
Economic and Business Science	Accounting	Accountant, Bookkeeper, Chartered Accountant

Once you have chosen a career field or two, you need to look at the specific vocation and occupations within that field. Ask yourself the following questions:

- What sub-fields are you interested in?
- What occupations are there in the sub-fields?
- What kind of work does each occupation involve? This includes questions such as where the work takes place – indoors or outdoors; in a laboratory or an office.
- What are the responsibilities of each occupation?
- What abilities are needed?
- What characteristics and traits are associated with the job?
- What are the qualifications required for this job?
- What compulsory subjects need to be studied for these qualifications?
- What symbols are required for admission to a higher education institution?
- What courses (degrees, diplomas and certificates) are available at institutions?

**Backup plans**

Most learners will probably be interested in more than one field, which is good because it is important to have a back-up plan.

After you have identified at least two fields, try to choose at least three occupations for each field. When you apply at an institution you need to indicate three options in case you do not qualify for admission into your first choice of study, or in cases where the number of students is limited and you do not make the cut-off.

Information about career fields, sub-fields and occupations can be gathered from:

- brochures from employers
- advertisements in newspapers
- career books • prospectuses and calendars of tertiary institutions
- career counsellors • people working in the relevant field or occupation
- the internet • open days at higher education institutions.



**3 Choosing the kind of institution at which to study**

You can study for a SET career at a university, university of technology or a Further Education and Training (FET) college (see pages 139-144 for a full list and contact details).

Each of these institutions has different academic entry requirements, but all are able to prepare you for some kind of career in the SET sector. All qualifications are equally desirable and produce graduates in high demand in the labour market. All SET skills are classified as scarce skills throughout the world.

Your choice of institution will depend on two issues: the kind of academic results you are likely to achieve; and whether or not your interest in SET is more practical and career-oriented as opposed to theoretical and academic.

**Universities**

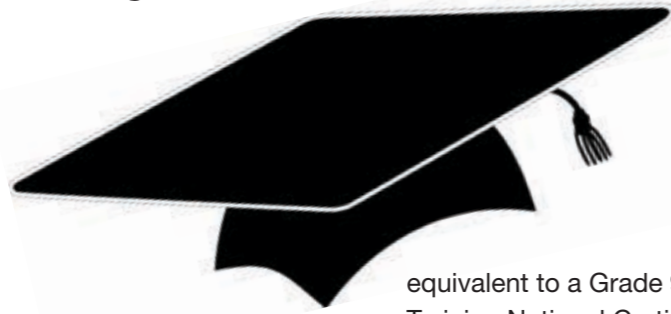
Top academic achievers, particularly in subjects like Maths and Physical Science, are likely to meet the symbol requirements for universities, which generally have a more theoretical approach to the study of SET-related subjects and can prepare you for postgraduate study or specialisation after your first degree. This could place you at the cutting edge of SET research and knowledge.

**Universities of Technology**

Those with a more practical interest in science, engineering and technology and who are job-focused should consider applying to a university of technology. Universities of technology offer vocationally oriented diplomas and degrees. Both universities of technology and FET colleges (see below) include a practical training component in their courses.



## section 1 – thinking ahead



### FET Colleges

Learners who pass Mathematics and Physical Science with more than 40% and who are also more practically oriented should consider studying at a FET college.

FET colleges provide ongoing education up to NQF (National Qualifications Framework) Level 4, which is the same level of education as matric, or Grade 12, which is also credited as NQF 4. These colleges focus on vocational training and accept students who are in possession of a NQF 1 certificate or an Adult Basic Education and Training (ABET) qualification Level 4. This is

equivalent to a Grade 9 General Education and Training National Certificate.

Education provided at FET colleges is seen as vocational training. This means that students are allowed to focus and specialise in one of 11 fields for which the National Certificate (Vocational) makes provision. Learners focus on one field of specialisation, obtaining NQF levels 2-4 in three years. This provides learners who do not intend to go to university or university of technology with an opportunity to obtain a specialised qualification and have excellent employment prospects.

## What do you need for admission into higher education institutions?

All institutions have different academic entry requirements. However, we have set out below some of the general requirements for study in the SET fields.

- Maths and Science are compulsory subjects for all SET careers, so you will need good symbols in Mathematics and Physical Science.
- A reasonably good symbol in English is needed and good performance in all subjects is important as an indication of general performance.
- Recommended subjects which are linked to your chosen SET career and are chosen as third and fourth subjects after Maths and Science. E.g. Life Sciences is recommended for those wishing to study Medicine. Recommended subjects may differ from institution to institution, so find out from your intended study institution what they require.
- Computer Science is a valuable course for all SET courses, although institutions offer introductory courses for students.

### Personal qualities

Goal-orientation and motivation to study are required, as well as an ability to learn independently, employ sound study habits and practice good time management.

Once you have decided which type of institution you want to study in, find out from those institutions when applications open and apply in good time.



### 4 Achieving your goals

After choosing the subjects required, study diligently and achieve the best symbols you can in all tests and examinations.

Remember, subjects such as Maths and Science cannot be studied the night or even the week before the test or examination. These subjects are made up of concepts which build on each other from primary to secondary school. You need to apply yourself in these subjects every day in order to understand each building block. If you get a low symbol in Grade 8, it means you should go back to the work covered in Grades 6 and 7 to make sure you understand the basic steps and then return to Grade 8 work.

Try to keep your sights fixed on your longer-term goal of a career in SET. Good luck and, most importantly, have fun!



# THINK.LEARN.DO.

Choosing a university is a huge decision and your choice will play a major role in your career aspirations. For those looking for a quality education at a multi-lingual and multi-cultural campus, a wise choice will be the Durban University of Technology (DUT). The DUT is committed to student centred excellence in higher education delivery. Collectively our six faculties deliver 74 academic programmes across five campuses located in Durban and two campuses in Pietermaritzburg.

As a university of technology, we remain at the cutting edge of research, innovation, science, technology and academic excellence. Our university boasts a wealth of knowledge in the form of highly qualified academic staff, ensuring that our students interface with people and the associated technologies aligned with the industries that we serve.

DUT's range of undergraduate and postgraduate studies in our six faculties includes the National Diploma, Bachelor of Technology, Masters and Doctoral Degrees and all are designed to give you a solid education and get you ahead in the world of work.

The DUT has over a 100 years of education experience and a wealth of knowledge that assists us towards developing world class graduates. Our Alumni like, Rob Ray - Art Director at Dreamworks Studio, Patrick Conway - Head of eNews, Sean Wisedale the first South African to scale the seven summits, Dion Chang, celebrity designer and fashion journalist, Gordon Murray, designer of FI Brabham & McLaren cars, McIntosh Polela - Spokesperson for the HAWKS, and Amanda Laird Cherry - top South African Fashion Designer, are just a few of the great names associated with our institution.

Lecturer and Doctoral student, Nokuthula Mchunu made world headlines recently in her ground breaking research in sequencing and decoding a thermophilic genome was carried out jointly at DUT and at the University of Sains Malaysia's Centre for Chemical Biology. Genomic sequencing refers to a combination of laboratory experiments and computer processing that elucidates the entire DNA sequence of a living organism. It is a world first and a milestone achievement for DUT.



Visit the DUT website to follow links to Facebook, Twitter and YouTube

[www.dut.ac.za](http://www.dut.ac.za)

## Minimum Requirements

Minimum requirements for Admission to Study at the Durban University of Technology is as follows:-

### National Senior Certificate

A National Senior Certificate (NSC) as certified by Umalusi, provided that a minimum of four recognised NSC 20-credit subjects must be passed. These four subjects must

- (i) Include English
- (ii) Not exceed two official languages and
- (iii) Have an achievement rating of 3 (moderate achievement 40%-49%) or better in accordance with the NSC levels of achievement below.

Over and above the minimum entrance requirement, each department also sets specific entrance requirements, with which applicants need to comply. These entrance requirements are subject to change. All applicants are required to undergo selection by the particular department.

## Open Days for 2013

Entrance to our Open Days is free for secondary schools and the public. See our website [www.dut.ac.za](http://www.dut.ac.za) for more information.

## Scholarships

- Undergraduate Scholarship: First Year Students – This award is made to first year full-time South African students who have obtained excellent results in the National Senior Certificate, which takes the form of a tuition fee remission as follows:-
- A first year student, who has obtained a National Senior Certificate with an aggregate of 80% or higher, shall qualify for a 100% remission of fees for the first year of registration.
- A first year student who has obtained a National Senior Certificate with an aggregate of between 70%-79% shall qualify for a 75% remission of tuition fees for the first year of registration.

For detailed information on scholarships, contact the Financial Aid Office on 031 373 2768/2726.

### Contact Details:

e-mail: [info@dut.ac.za](mailto:info@dut.ac.za)

Call Centre 0860 10 31 94

Apply through CAO: Tel (031) 268 4444



- Analytical Chemistry
- Biotechnology
- Clothing Management
- Consumer Science: Food and Nutrition
- Food Technology
- Horticulture
- Maritime Studies
- Sport Management
- Textile Technology (Dry/Wet Processing)

- Architectural Technology
- Construction Management and Quantity Surveying
- Building
- Engineering: Chemical
- Engineering: Civil
- Engineering: Computer Systems
- Engineering: Electrical (Light Current)
- Engineering: Electrical (Power)
- Engineering: Industrial
- Engineering: Mechanical
- Engineering: Pulp and Paper Technology
- Surveying
- Town and Regional Planning

- Biomedical and Clinical Technology
- Community Health Studies
- Chiropractic and Somatology
- Dental Sciences
- Emergency Medical Care
- Homoeopathy
- Nursing
- Radiography





# Engineering

## Keeping the wheels of society turning

Engineering is a broad discipline which involves the design, building, maintenance and development of things – engines, machines and structures – that are needed by human beings but do not exist in the natural world.

Engineering uses Science, Maths and Technology to solve problems by finding the most suitable solution. An important part of Engineering involves identifying and understanding the constraints of a design, to enable it to function successfully within these limits.

Quick check:  
Is Engineering a suitable career path for you?

Ask yourself the following questions:

- Are you curious about how things work and do you like to solve problems?
- Do you enjoy working in a team and want to create things that will improve people's lives?
- Do you have an aptitude for Maths and Science?

If the answers to these questions are 'yes', you should consider a career as an engineer. Read on!





There are four professional categories of engineer, according to the Engineering Profession Act (No 46 of 2000):

- **Professional Engineer** – entry level qualification is a BSc (Eng)/ BEng, four-year degree
- **Professional Engineering Technologist** – entry level qualification is a BTech (Eng) degree
- **Professional Certificated Engineer** – entry level qualification is a Government Certificate of Competency
- **Professional Engineering Technician** – entry level qualification is a three-year diploma in Engineering from a University of Technology

To study for a BEng, you will need to achieve a senior certificate with about 60% in both Mathematics (not Mathematical Literacy) and Physical Science and an overall average of 60%.

To study for a BTech, you will need a senior certificate with a minimum of 40% in Mathematics (not Mathematical Literacy) and Physical Science.

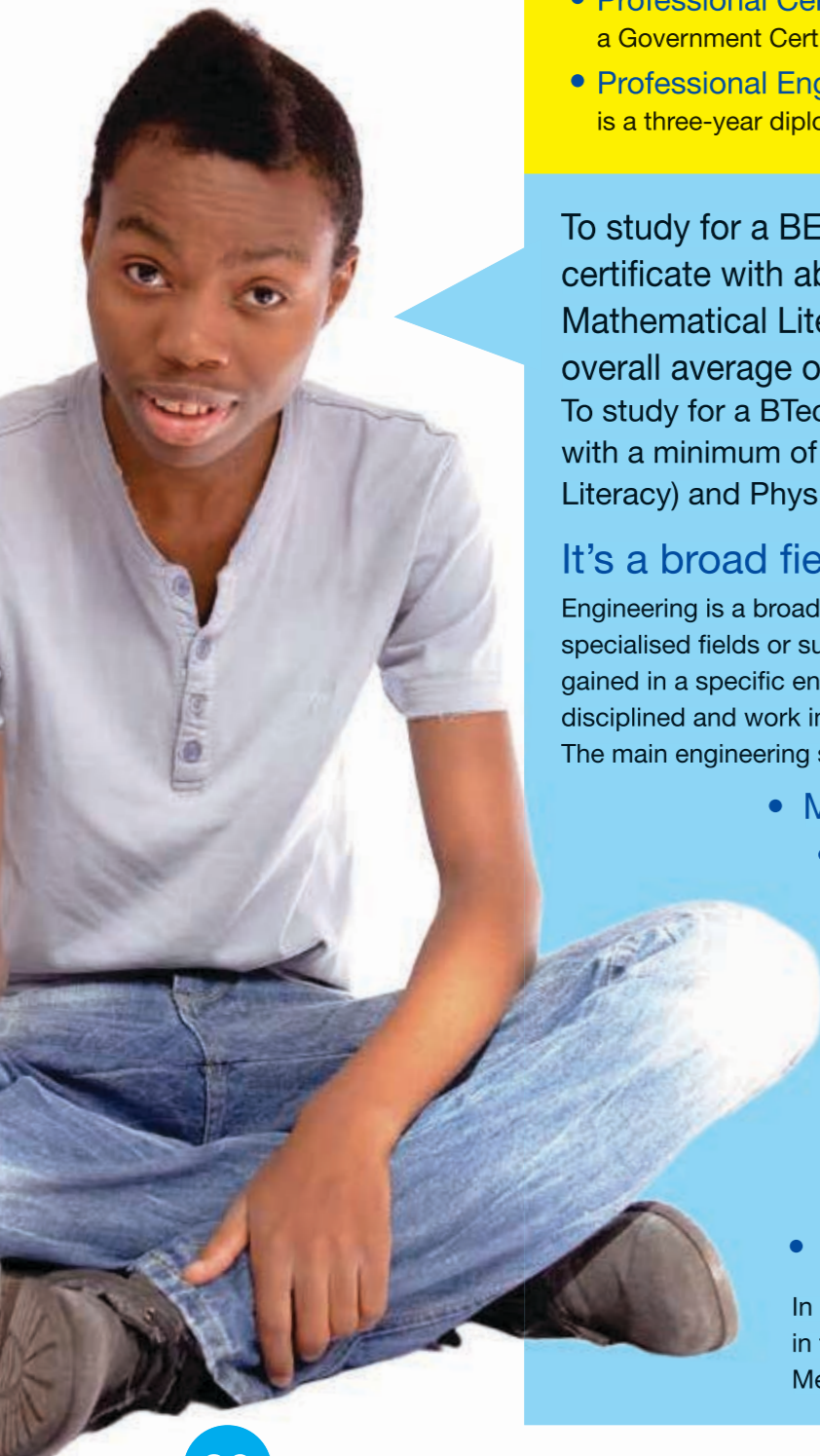
### It's a broad field with many options ...

Engineering is a broad discipline which can be divided into many specialised fields or sub-disciplines. Although initial training is usually gained in a specific engineering field, an engineer can become multi-disciplined and work in several engineering fields during their career. The main engineering sub-disciplines or specialisations are listed below:

- **Mechanical Engineering**
  - Civil Engineering
  - Chemical Engineering
  - Electrical Engineering
  - Aeronautical Engineering
  - Mining Engineering
  - Industrial Engineering
  - Agricultural Engineering
- **Materials Engineering**
- **Environmental Engineering**

In addition to these, specialisation is also possible in fields such as Biomedical Engineering and Measurement and Control Engineering.

**Don't forget, South Africa needs SET skills!** Outlining a new economic growth path in 2010, South African Economic Development Minister Ebrahim Patel said the government was targeting the training of at least 30 000 additional engineers by 2014 and at least 50 000 additional artisans by 2015.





## Mechanical Engineer

Mechanical engineers deal with power and movement and are involved in manufacturing equipment and developing improved manufacturing techniques. Mechanical Engineering is the broadest of all engineering fields.

### Arinao Novhe

“ My key responsibilities included the design of new lubrication equipment and modifying existing equipment, visually inspecting railway tracks and measuring the different parameters such as rail gauge and cracks on the rail. ”

**Job:** Mechanical Engineer

**Where:** Steinmüller Engineering Services

**Qualifications:** BSc (Mechanical Engineering), Certificate in Computer Architecture

**What I do:** Steinmüller is an international company involved in the design and fabrication of industrial plants with a focus on optimising day-to-day plant operations and performance, including repairs and maintenance. I am currently involved in the refurbishment of economisers at Kriel power station and the replacement of high pressure heaters at Hendrina power station.

**How I got here:** After completing high school in Limpopo with good grades in Mathematics and Physical Science, I studied at the University of Cape Town with a bursary from Spoornet. I began working for them in January 2007 as a Mechanical Engineer.

**Where can mechanical engineers work?**  
In power plants and the petrochemical, mining and manufacturing industries



## Electrical Engineer

Electrical engineers deal with the study and application of electricity, electrostatics and electromagnetism. This field covers a range of sub-areas of study, including power, electronics, control systems, signal processing and telecommunications.

**Max Chauke**

**Job:** Technical Manager

**Where:** Thokomelo Consulting Engineers

**Qualifications:** BSc (Electrical Engineering), MSc (Electrical Engineering)

**What I do:** I oversee all the company's electrical designs for constructions and substations.

**How I got here:** I graduated from the University of Witwatersrand with a BSc in Electrical Engineering in 2001, specialising in power engineering. I continued to study part-time at Wits and completed my Master's in 2006. During my first job as an electrical engineer-in-training at ABB Powertech Transformers in Pretoria, I travelled extensively, undertaking training courses in Sweden, Switzerland, England, Canada and Brazil. I then spent two years at Eskom as an electrical engineer, designing new power stations and developing specifications for the refurbishment of existing power stations.



**Job:** Electrical Engineer

**Where:** Research, Test and Development Unit in Eskom’s Sustainability Division

**Qualifications:** BEng (Electrical Engineering), MSc (Electrical Engineering)

**What I do:** I help identify, test, demonstrate and advise the relevant sections of Eskom on new and emerging technologies which can be adopted to reduce energy consumption, decrease reliance on coal power and thus reduce Eskom’s and the nation’s carbon footprint.

**How I got here:** I was inspired to study electrical engineering out of sheer curiosity. I wanted to learn more about the technologies and engineering used to generate, transmit and distribute electricity up to the point of consumption. The recent power challenges, combined with environmental issues, inspired me to study further and learn more about technologies to address them. Playing an innovative role in the development of South Africa’s sustainable energy industry and world-class utility is rewarding work.

**Where can electrical engineers work?**

Electrical engineers are employed by power plants, the petrochemical, mining, manufacturing and telecommunication industries, the banking sector, consulting engineering firms, laboratories, designers and producers of electrical components, and electricity suppliers.

“ These are exciting times for the energy sector where energy security is at the forefront of business goals. Be prepared for exciting new developments ranging from renewable energy power generation to the efficient use of energy and intelligent demand control such as smart grid technologies, green buildings and more. ”

**Gloria Moholi**





## Segomotso Kelefetswe

Job: Dam Engineer

Where: Arcus Gibbs, an engineering consulting firm

Qualifications: BSc (Civil Engineering)

**What I do:** I work in the Heavy Engineering division. My job involves the planning, design, construction, inspection and maintenance of dams and hydropower schemes. I look at scientific aspects of the design, analysis and modelling of dams which requires a wide spectrum of engineering knowledge in geology, hydrology, hydraulics, materials and structures, and some interaction with mechanical and electrical engineering. I am currently specialising in materials engineering, with a specific focus on roller compacted concrete.

**How I got here:** After completing my studies at the University of Witwatersrand, I began my career working at the Department of Water Affairs and Forestry, dealing with the monitoring and inspection of dams in terms of dam safety legislation. I then worked as a design engineer for the Raising of the Flag Boshielo Dam in Marble Hall. I also did the rehabilitation, maintenance and betterment works involved in the preliminary design and option analysis for the remedial work for Glen Brock Dam in the Eastern Cape.

**Where can civil engineers work?** Consulting companies, the construction industry, municipalities and power plants. The public sector also employs civil engineers.



### Civil Engineer

Civil engineers focus on creating, providing and improving facilities for everyday living, industry and transportation. This includes work on water supply and irrigation systems, dams, water purification plants, storm water systems, flood control structures, sewerage systems, sewage works, harbours, docks, tunnels, canals, bridges, roads, motorways, large buildings, sports stadiums, railways and airports.



**Job:** Environmental Engineer

**Where:** NECSA, the South African Nuclear Energy Corporation

**Qualifications:** NDip (Chemical Engineering), BTech (Chemical Engineering), BSC Hons (Environmental Engineering)

**How I got here:** After obtaining my National Diploma in Chemical Engineering at the University of Johannesburg, I completed my BTech at Tshwane University of Technology.

I continued to study part-time for my honours degree at the University of Pretoria and began my career at Eskom as a trainee Chemical Engineer, where I was responsible for operating the electrochemical reactor used for wastewater treatment. I was also involved in research on plasma heating technology used for solid waste treatment. When I joined NECSA as a technician, I was responsible for the characterisation of nuclear waste before disposal using gamma spectrometry. After completing my studies I was appointed as an Environmental Engineer.

**Where can chemical engineers work?**

Job opportunities are available at chemical or mineral processing plants and consulting firms, higher education institutions, science councils and research laboratories.



**Venus Nkuna**

“ I am currently responsible for safety and risk assessments, safety cases, hazards and operability studies, incident investigations and environmental impact studies. ”

# Chemical Engineer

Chemical engineers apply Mathematics and Physical Science to convert raw materials or chemicals into more useful or valuable forms. As well as producing useful materials, chemical engineering also involves pioneering valuable new materials and techniques, which are important in research and development.



## Aeronautical engineer

Aeronautical engineering is a specialised branch of mechanical engineering. Aeronautical engineers deal with the design and analysis of the performance of air vehicles such as fixed wing aircraft, helicopters, missiles, bombs, rockets, launch vehicles and unmanned aerial vehicles.

### Where can aeronautical engineers work?

Job opportunities are available at companies designing aircraft airframes, unmanned aerial vehicles, missiles and bombs, as well as at research institutions.

Jobs are available at major aeronautical organisations, such as Aerosud, the Civil Aviation Authority, Denel SAAB Aero Structures, Denel Aviation, South African Airways, as well as many other active smaller companies working and competing in both local and international aerospace programmes.

## Industrial engineer

Industrial engineers try to find the best way to do things by engineering processes and systems that improve quality, productivity and safety. They work to eliminate waste of time, money, materials, energy and other resources to achieve what is known as “lean manufacturing”.

### Where can industrial engineers work?

Careers can be pursued in consulting and communication and service organisations such as banks and hospitals, transportation, educational institutions, manufacturing and other industries.

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... sharing the excitement and achievements of science in daily life

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... transforming lives by educating a new generation of young scientists

**TRANSFORM**



The South African Agency for Science and Technology Advancement (SAASTA) is opening people's eyes to the wonder of science by listening and communicating; by engaging with them and making them aware of new scientific knowledge; by working together and sharing the excitement of science; and by building a new generation of young scientists. For more information visit [www.saasta.ac.za](http://www.saasta.ac.za)



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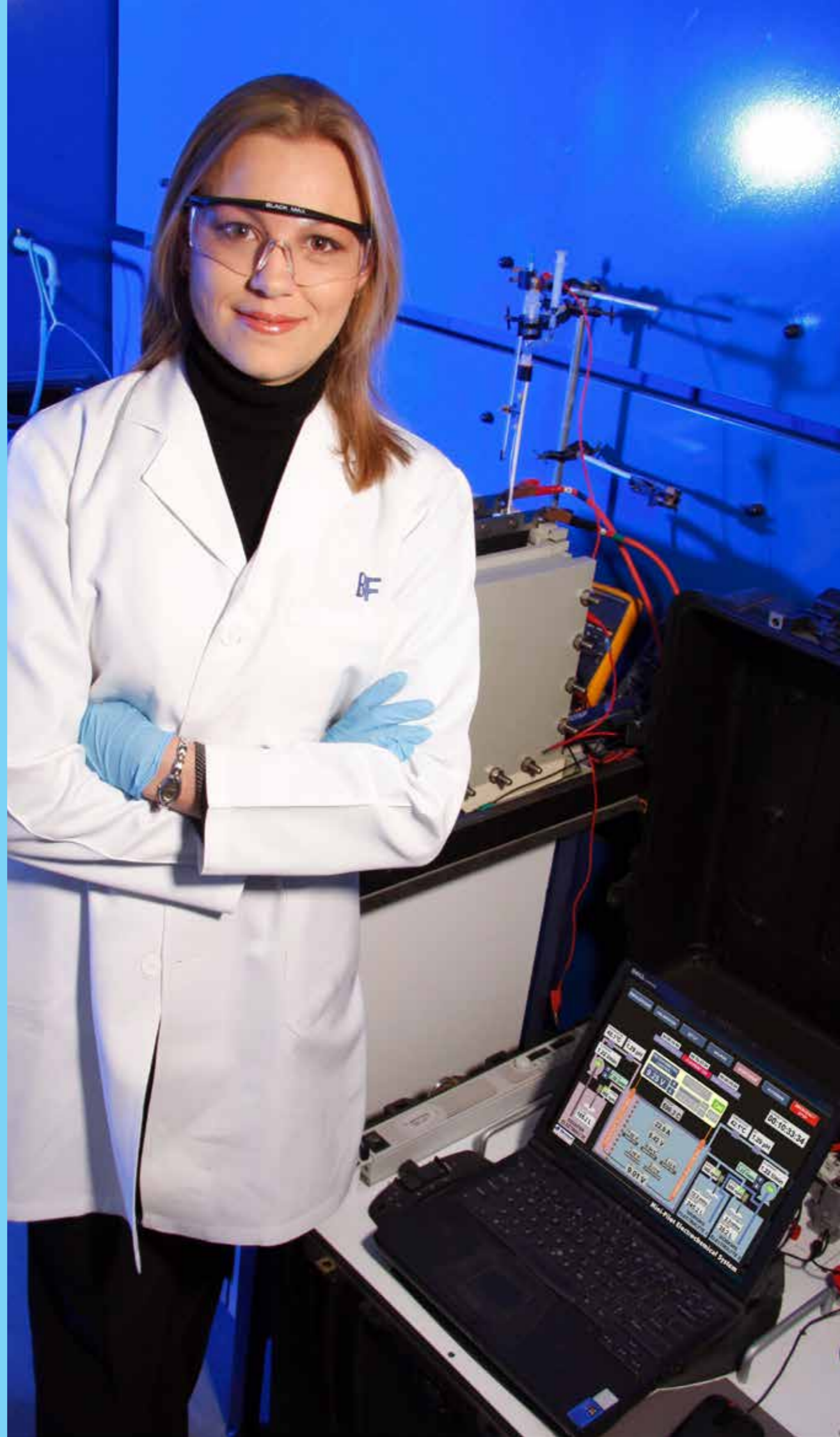
## Bronwynne Ferreira's advice:

“ While the work can be very demanding and challenging at times, it is also incredibly satisfying. ”

# Metallurgical and Materials Engineer

Metallurgical and materials engineering deals with a variety of metal-related areas. The three main branches are:

- **Physical Metallurgy**, which deals with problem-solving. The engineer develops the sorts of metallic alloys needed for different types of manufacturing and construction;
- **Extractive Metallurgy**, which involves extracting metal from ore;
- **Mineral Processing**, which involves gathering mineral products from the Earth's crust.



**Job:** Principal Metallurgist

**Where:** Anglo Research

**Qualifications:** BSc (Chemical Engineering), MSc (Chemical Engineering)

**What I do:** My work involves developing and designing new methods and technology to recover precious metals such as platinum, palladium and rhodium. The work varies, but includes laboratory-based work for small-scale experiments, which are then tested on a mini-plant before designing and constructing the full-scale operation at the refinery.

**How I got here:** I completed my studies at the University of the Witwatersrand

with bursary support from Anglo Platinum and then began work at Anglo Research in the Extractive Metallurgy Department, in the section for separation and refining processes.

**Where can metallurgical engineers work?** The mining industry, the base metal industry, science councils such as MINTEK, research councils such as the Council for Scientific and Industrial Research (CSIR), consulting firms and many more organisations employ metallurgical engineers.



**Job:** Senior Mining Engineer

**Where:** Exxaro Coal

**Qualifications:** BSc (Mining Engineering)

**What I do:** I focus on mine planning and budgeting, project engineering, performance analysis on mining equipment, optimisation of the use of resources, efficient and safe operation of the mining process.

**How I got here:** I completed my degree at the University of the Witwatersrand in 2001 with the help of a bursary from AngloGold, and then obtained my Blasting Certificate for Fiery Mines in 2002 and my Mine Manager's Certificate of Competency in 2006.

Upon completion of my training as a mining graduate trainee at Anglo Coal in 2003, I moved to BHP Billiton as a shift overseer and a mine planning engineer for two years.

**Where can mining engineers work?** Mining engineers are employed by the mining and base metal industries such as Implats, Anglo Coal, BHP Billiton and many others.

## Mining Engineer

A Mining Engineer designs mines to ensure that the process of mining (extracting minerals from ore) is as safe and as economical as possible.

### Tsunsuka Bamuza's advice:

“ To succeed, we need to make certain that we are interested in and passionate about what we do. We can do just about anything as long as we have the right attitude and put our minds to it. ”





## Agricultural Engineer

Agricultural engineers design agricultural machinery, equipment and agricultural structures. They may perform tasks such as planning, supervising and managing the building of dairy effluent schemes, irrigation, drainage, flood and water control systems, and perform environmental impact assessments.

### Where can agricultural engineers work?

Employers of Agricultural Engineers include the agricultural sector (farms, dairy factories, cattle and poultry feedlots, cold rooms, irrigation, drainage and flood and water control systems), government, research councils and higher education institutions such as agricultural colleges or universities. Agricultural engineers may also be employed in forestry industries, biofuel industries, food processing and packaging industries, the environmental sector, water-focused industries and also the sugar industry.

## Measurement and Control Engineer

The measurement and control engineer needs to understand the basics of all engineering sub-disciplines to be able to correctly specify and use equipment for a specific purpose. Measurement and control engineering is highly technical, extremely interesting and dynamic.

### Where can measurement and control engineers work?

Virtually every industry makes some use of measurement and control and there is large scope for employment as part of a dynamic engineering team. The following industries all make extensive use of measurement and control: aeronautical and aerospace, biological, chemical, computer, construction, electric power, electronics, engineering, food processing, glass and ceramics, marine science, medicine, mining and metallurgy, nuclear, petrochemical, petroleum, pulp and paper, textiles, transportation, water and waste treatment.

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# Make it happen



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Contact Prof Andrew Leitch, Dean of the Faculty of Science  
Tel: 041 504 2268 • E-mail: [andrew.leitch@nmmu.ac.za](mailto:andrew.leitch@nmmu.ac.za)





## Biomedical Engineer

**Biomedical engineers apply engineering principles and techniques to the medical field.** They combine the design and problem-solving skills of engineering with medical and biological science to help improve patient health care and quality of life by diagnosing and treating disease. Biomedical engineering is a relatively new field and includes the following sub-disciplines:

- **Clinical engineers** who are responsible for acquiring and managing medical equipment in a hospital and ensure that safety and regulatory issues are taken into consideration. They also serve as technological consultants and work closely with the IT department and medical physicists;
- **Medical device engineers** who develop and manage medical devices used to diagnose, cure, treat and prevent disease. Some examples of devices include the heart-lung machine, artificial organs, implants, artificial limbs and corrective lenses;
- **Tissue engineers** who research and develop methods of creating artificial organs, for example bladders, for patients who need organ transplants. This also includes bio-artificial organs, which use both synthetic (non-living) and biological (living) components.

### Where can biomedical engineers work?

Jobs for biomedical degrees are available in research institutions and councils, hospitals and institutions that deal with medicine.

### Where can I get more information about Engineering?

Engineering Council of South Africa (ECSA)

Private Bag X691  
Bruma 2026

Tel: 011 607 9579 / 011 607 9500

Fax: 011 622 9295

Website: [www.ecsa.co.za](http://www.ecsa.co.za)



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of Technology  
*We empower people*



## Faculty of Information and Communication Technology

**D**o you have a keen interest in computers? Are you a creative problem solver? Do you have the potential to work hard and to commit yourself? Do you have the ability to think in a logical and critical manner? Are you enthusiastic, creative and open-minded? Then the Faculty of ICT (Information and Communication Technology) would like to invite you to join us by applying for one of our qualifications.

In the National Diploma Information Technology (IT), all students enrol for a general first year where they are introduced to basic computer principles and programming, operating systems, networks and entrepreneurial and life skills. Students that successfully completed the general first year may start to specialize from the second year and can then register for any of the following fields of specialisation:

- National Diploma: Information Technology: Business Applications
- National Diploma: Information Technology: Communication Networks
- National Diploma: Information Technology: Intelligent Industrial Systems
- National Diploma: Information Technology: Multimedia
- National Diploma: Information Technology: Software Development
- National Diploma: Information Technology: Support Services
- National Diploma: Information Technology: Technical Applications
- National Diploma: Information Technology: Web and Application Development

For those who would like an additional challenge with some focus on the Engineering concepts of the ICT field we also offer a National Diploma: Engineering: Computer Systems (CS). All diplomas can be furthered to B.Tech, M.Tech and D.Tech level.

### Admission Requirements:

A National Senior Certificate with an endorsement of a Bachelor's degree or a Diploma or an equivalent qualification (FET Certificate (NCV)), with English (home language or first additional language) (3:IT and 4:CS) and Mathematics (4). For CS, Physical Science (4) is also a prerequisite. Candidates with Mathematics (3) or Mathematical Literacy (5) will be considered for admission to the Foundation Programme.

### Selection Criteria:

To be considered for this qualification, candidates must have an Admission Points Score (APS) with a minimum of 18 (with Mathematics) or a minimum of 20 (with Mathematical Literacy).

**Intake:** Only in January

**Presentation:** Day classes

**Campus:** Soshanguve South (All IT specialization directions and Computer Systems)  
eMalahleni (Only Software Development)  
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You can also visit our website and apply online: [www.tut.ac.za](http://www.tut.ac.za)



# Space

reach for  
the stars

## Space - vast opportunity

Space science and technology is a rapidly emerging field in South Africa. People usually think of space science as being about the big questions – like, “How did the universe form?” “What is dark matter?” – but today space science and technology is a broad field cutting across many traditional disciplines such as mathematics, chemistry, physics, biology, engineering and geology.

- **Space science** is the study or use of everything above and beyond the Earth’s surface, from the atmosphere to the edges of the universe, e.g. astronomy, space physics and geodesy (a branch of applied mathematics and Earth science dealing with the measurement and representation of the Earth and its gravitational field).
- **Space technology** is the study or use of technology in satellite and ground systems used to study the universe (looking up) and the Earth (looking down). Through techniques such as remote sensing and geographical information systems, South Africa’s space scientists, technologists and engineers can help us better manage our natural resources and provide information for agricultural and water management, disaster relief, and even peace-keeping operations.
- Space science and technology also includes **space-based systems** which have become an important part of our modern information society, touching our daily lives in the form of cell phones, the Internet, ATMs and satellite TV.



# South Africa at the cutting edge

Space science is a rapidly growing field in South Africa and is seen as a significant contributor to future sustainable development on the African continent.

South Africa has some of the world's best space infrastructure. This includes the Southern African Large Telescope (SALT), the single largest optical telescope in the southern hemisphere, and the SumbandilaSat, a relatively low-cost satellite made in South Africa to take images from space of the Southern African region to help with research planning and management.

The successful manufacture and launch of SumbandilaSat in 2009 means South Africa has experience and expertise in the manufacture of satellites, and the launch of further versions of SumbandilaSat is planned over the next 10 years or so. In addition, South Africa won the bid in 2012 to co-host with Australia the Square Kilometre Array (see information box), which will be the largest radio telescope in the world.

## What is the SKA?

The Square Kilometre Array, or SKA for short, will be a giant radio telescope made up of more than 3 000 antennae.

Its huge size means it will be up to 10 000 times more powerful than existing telescopes. It will be sensitive enough to detect signals from the Big Bang. Thus it could provide answers to fundamental questions about the origin and evolution of the Universe.

In 2012, it was announced that South Africa would share the hosting of the R23 billion telescope with Australia, with Africa hosting about 70% of the antennae.

Construction of a precursor to SKA, the 64-dish MeerKAT in the Northern Cape, is already under way.

The SKA is expected to provide a range of SET-related jobs in South Africa and bring a lot of skills and new knowledge into the country.



### Where can remote sensing and GIS researchers work?

Because of the broad application of their work, they can be found in a wide range of places, including research institutes, academic institutions, the environmental or agricultural sector, the military or government.

### What you need to get there:

School subjects:  
Mathematics, Physical Science

University qualifications:  
A degree in Engineering (electrical), or a BSc degree with a major in Physics.

### Lufuno Vhengani's advice:

“ Remember that GIS and RS are rapidly developing fields. That means that there is something new to learn almost every week and one has to keep studying to keep abreast of new technological developments. So, if you like learning new things, this might be the job for you. ”

space – reach for the stars

**Job:** Remote sensing and Geographic Information Systems (GIS) researcher

**Where:** The Council for Scientific and Industrial Research (CSIR)

**Qualifications:** Post-graduate diploma in satellite engineering (from Stellenbosch University) and a master's degree in Satellite Remote Sensing (from the French Aero-space Remote Sensing Development Group in Toulouse) and an honours degree in Physics.

**A typical day:** Vhengani spends a lot of his day reading and searching for information for his various projects. There is sometimes fieldwork to be done and often he spends time processing data and writing reports.

A fun part of his work involves travelling and meeting people and sharing ideas with those who work in similar fields.

**Why my job is important:** South Africa needs the skills to design, build and operate its own satellites and the skills to interpret and derive useful information from satellite data. Even if this is not where your specific interest lies, there are other disciplines such as astronomy and with the development of the SKA, the future looks bright.

**Why did you choose this path?** I have always been inspired by Maths and Science and was introduced to satellite remote sensing after completing my honours degree in Physics. The Institute of Satellite and Software Application then gave me the opportunity to study further in the field.



space – reach for the stars

## What is Geoinformatics?

‘Geo’ means Earth and ‘Informatics’ means information. Thus Geoinformatics is a field of space science focused on understanding the Earth and planetary bodies. It involves the acquisition, storage, presentation and dissemination of ‘geoinformation’.

### Where can geoinformatics experts work?

Because of the broad application of their work, they can be found in a wide range of places, including research institutes, academic institutions, the environmental or agricultural sectors, the public and private sectors.

### What you need to get there:

School subjects:  
Mathematics, Physical Science, Geography

University qualifications:  
Geomatics, Earth Science, Geology, GIS/RS and Computer Science

### Andiswa Mlisa’s advice:

“ Develop above-average computer skills to keep up with developing technology. Also, your job is to bridge the gap between technology and applications, so work on your communication and interpersonal skills. ”

**Job:** Geoinformatics specialist (GIS) researcher

**Where:** Umvoto Africa, a water resource development consultancy which focuses on hydrogeology and mining exploration. Mlisa leads the Geoinformatics Division which combines both geographical information systems and remote sensing.

**Qualifications:** BSc majoring in Geology, BSc (Honours). She is currently enrolled for her MSc degree in GIS with the University of Stellenbosch.

**A typical day:** Mlisa combines her knowledge of geology and technology to interpret various data. She spends a lot of time capturing data and collating information and imagery. She then pre-processes the data for analysis and classification, providing information to the natural scientists in her organisation and outside clients. Sometimes she goes on site visits. She also mentors young undergraduates and post-graduate students and serves on national and international committees.

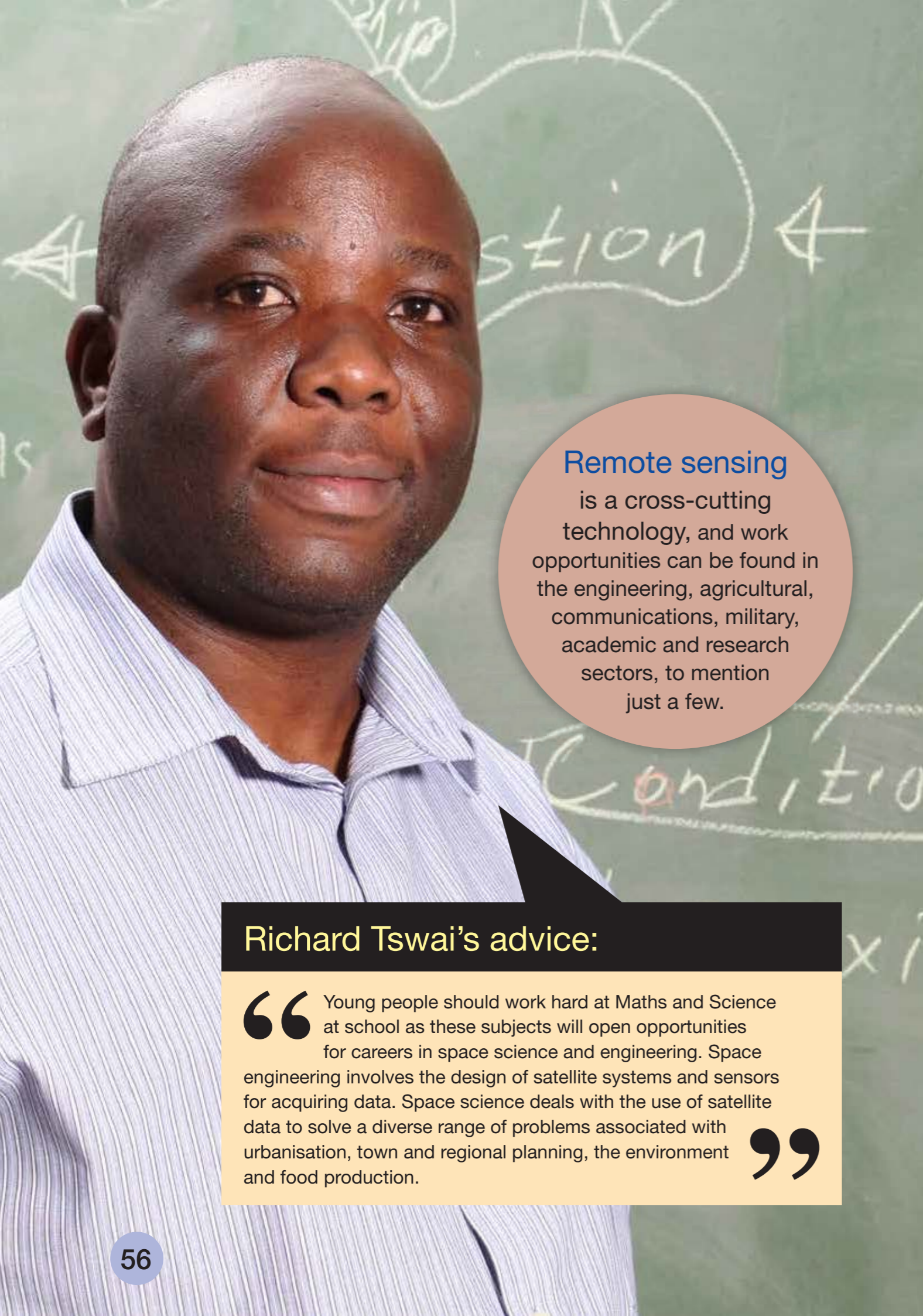
**Research focus:** Mlisa’s special interest is in using remote sensing techniques, such as satellite image processing, for groundwater and environmental studies. She has used remote sensing and GIS technology to tackle projects such as finding diamond-bearing kimberlites in Angola and Brazil and for water resource development and management.

**Why my job is important:** The time is ripe to choose space science as a career and there are many initiatives on the go to support the growth of space science in South Africa. It’s an exciting field which allows us to use satellite and other technology to ensure integrated water resource management and sustainable development, for example, and even manage natural disasters.

### Why did you choose this path?

I have always loved problem-solving and this job gives me lots of opportunity to find and analyse information needed to find solutions and understand the way things work.





**Remote sensing** is a cross-cutting technology, and work opportunities can be found in the engineering, agricultural, communications, military, academic and research sectors, to mention just a few.

**Richard Tswai's advice:**

“ Young people should work hard at Maths and Science at school as these subjects will open opportunities for careers in space science and engineering. Space engineering involves the design of satellite systems and sensors for acquiring data. Space science deals with the use of satellite data to solve a diverse range of problems associated with urbanisation, town and regional planning, the environment and food production. ”

**Job:** Remote sensing researcher

**Where:** Agricultural Research Council (ARC)'s Institute for Soil, Climate and Water.

**Qualifications:** Postgraduate diploma in satellite systems offered by the Institute for Satellite and Software Application (ISSA) in collaboration with the University of Stellenbosch.

**A typical day:** Richard processes and analyses multispectral data from satellite sensors and spectral data from a spectrometer instrument for various applications.

The work entails the daily management of projects, drafting proposals for new projects, analysing data, compiling scientific reports, planning and giving presentations at workshops, and attending conferences.

**What you need to become a space scientist:**

**School subjects:** Mathematics, Physical Science and Geography at school are needed to study for space-related degrees.

**University qualifications:** A number of South African universities offer space-related courses.

**Why did you choose this path?**

My goal is to be a specialist scientist in remote sensing. I plan to explore microwave remote sensing technologies and how they can be used in agricultural research.



## South Africa makes its own satellites

**Sunspace and Information Systems Ltd is one of only two manufacturers of satellite systems in South Africa.**

It manufactured SumbadilaSat, the R26 million low-orbit satellite which produced images of the Southern African region.

The satellite was the result of a development programme conducted at the University of Stellenbosch's Engineering faculty on behalf of the Department of Science and Technology.

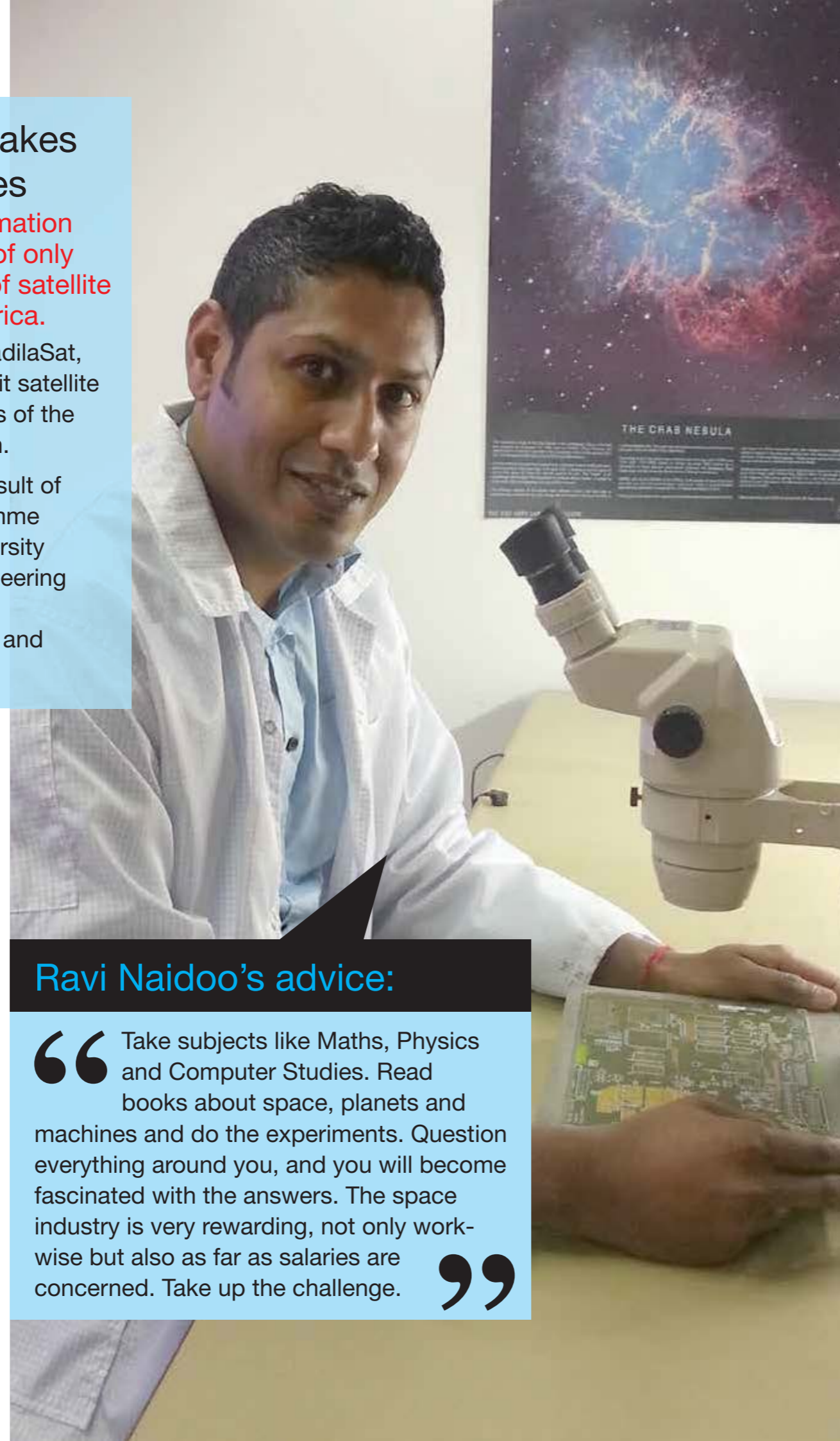
### Where can space-related mechanical engineers work?

Because of the broad application of their work, they can be found in a wide range of places, including research institutes, academic institutions and the private sector.

### What you need to get there:

School subjects:  
Mathematics and Science.

Tertiary qualifications:  
BTech degree in Mechanical Engineering or a university degree in Mechanical Engineering.



### Ravi Naidoo's advice:

“ Take subjects like Maths, Physics and Computer Studies. Read books about space, planets and machines and do the experiments. Question everything around you, and you will become fascinated with the answers. The space industry is very rewarding, not only work-wise but also as far as salaries are concerned. Take up the challenge. ”

space – reach for the stars

**Job:** Mechanical engineer and team leader

**Where:** Sunspace and Information Systems Ltd, a private company that builds high performance small and medium sized satellites and related systems for the local and international aerospace market. Naidoo is the leader of a production team.

**Qualifications:** BTech in Mechanical Engineering.

**A typical day:** Naidoo assembles electronic circuit boards used to control satellites. He ensures that his team works at consistently high levels of quality and international standards are maintained. If a circuit board is not built according to the set standards, the satellite will be less reliable. Naidoo also gets to do hands-on work like spray painting, satellite assembly, vacuum simulation testing of the satellite. He also travels overseas for commissioning of satellite project phases.

On any ordinary day, Naidoo can be found identifying problems, working with people, learning from professionals, sharing his own knowledge and motivating others.

**Why my job is important:** Satellites are becoming integral features of our modern world and South Africa is now playing an important role in their production.

**Why did you choose this path?** When I was growing up, I found opening toys and radios to see how they work very exciting, so when I grew up I studied Mechanical Engineering at Cape Technikon, now the Cape Peninsula University of Technology. I had no idea that 10 years later, I would be involved in building space satellites.

If you have a passion for the space industry, an interest in maths, physics, computers, general science and technology and are a continuous learner and a disciplined person, this profession could be for you.



## Studying space science

To follow a career in space science you will need to do well in school subjects like Mathematics and Science. This will allow you to enrol for courses in Maths, Physics or Engineering at university and at FET colleges and universities of technology.

Many universities offer postgraduate courses in space science and remote sensing.

- The National Astronomy and Space Science Programme; University of Cape Town; [www.star.ac.za](http://www.star.ac.za)
- University of Cape Town Department of Astronomy; <http://mensa.ast.uct.ac.za>
- University of the Free State Department of Physics; [www.uovs.ac.za](http://www.uovs.ac.za)
- University of KwaZulu-Natal School of Physics; [www.ukzn.ac.za](http://www.ukzn.ac.za)
- University of the North West Physics Department; [www.nwu.ac.za](http://www.nwu.ac.za)
- Rhodes University Department of Physics and Electronics; <http://jansky.ru.ac.za/physics/>
- University of South Africa Department of Mathematics, Applied Mathematics and Astronomy; [www.unisa.ac.za](http://www.unisa.ac.za)
- University of Stellenbosch Department of Electrical and Electronic Engineering; [www.ee.sun.ac.za](http://www.ee.sun.ac.za)
- University of the Witwatersrand School of Computational and Applied Mathematics; [www.cam.wits.ac.za](http://www.cam.wits.ac.za)
- University of Johannesburg Faculties of Science and Engineering; [www.uj.ac.za](http://www.uj.ac.za)
- University of Fort Hare School of Science and Technology; [www.ufh.ac.za](http://www.ufh.ac.za)
- University of Venda for Science and Technology Faculty of Natural and Applied Sciences; [www.univen.ac.za](http://www.univen.ac.za)
- University of Limpopo Faculty of Sciences, Health and Agriculture; [www.unorth.ac.za](http://www.unorth.ac.za)
- University of Pretoria Faculties of Engineering, Natural and Agricultural Sciences; [www.up.ac.za](http://www.up.ac.za)



## Change the world you live in with a SET career

South Africa's scientists and engineers are recognised globally for their significant contribution to science, engineering and technology (SET). Join this vibrant community and contribute to changing the way we live – through new innovation and discoveries.

Kick-start your future in SET by visiting [www.sciencebursaries.org.za](http://www.sciencebursaries.org.za) and access a wealth of information on bursary and career opportunities!

SET for Life – Studying in the sciences will equip you for life!



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REPUBLIC OF SOUTH AFRICA



# Energy— meeting our needs

## One of the biggest challenges of our time

Our global energy system is in crisis. As the population grows, so does the demand for energy. But the world is running out of fossil fuels such as coal, oil and natural gas on which it still depends for most of its energy.

The demand for energy is predicted to increase by more than 50% by 2025. That makes the search for alternative energy sources one of the biggest challenges of our time.

## What is energy security?

Energy security is the capacity of a nation to produce or access enough energy to meet all its needs and those of its citizens at an affordable price.

Increasingly, the concept embraces the notion of sustainability – finding renewable and clean energy sources to protect the environment as well as meet demand for power.

## What is global warming?

The temperature of the Earth is rising as a result of our use of fossil fuels. When burned, fossil fuels produce greenhouse gases, including carbon dioxide, which trap heat close to the Earth's surface, causing a rise in the Earth's temperature.



# You can help

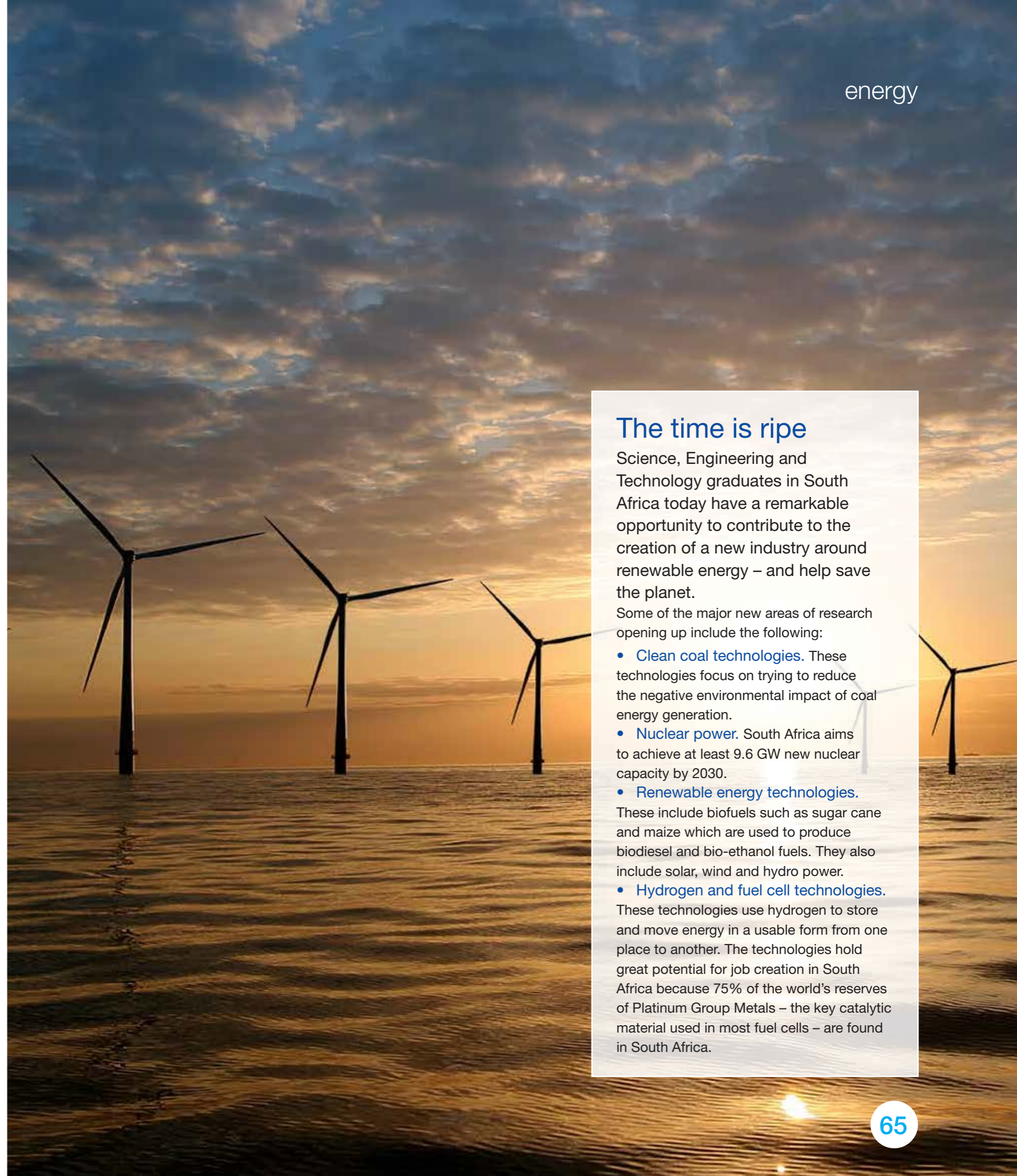
The need for energy security experts to help find renewable energy sources and develop sustainable energy technologies – to meet the demand for power and to save our planet – has become a global priority.

In South Africa, the need is also pressing.

Owing to rapid industrialisation, economic growth and mass government electrification programmes, demand for electricity exceeded supply around 2008 and the country has been affected since then by power cuts.

In South Africa, almost 80% of commercial electricity is produced by coal of which we still have large natural supplies. This makes us one of the highest producers of greenhouse gases in the developing world and the 14th highest producer in the world.

In terms of its Integrated Electricity Resource Plan (IRP) South Africa aims to reduce energy from coal to less than 50% by 2030 by producing energy through gas turbines, nuclear, hydro power and other renewable sources such as wind and sun. Research and development initiatives are flourishing and attracting significant investment.



## The time is ripe

Science, Engineering and Technology graduates in South Africa today have a remarkable opportunity to contribute to the creation of a new industry around renewable energy – and help save the planet.

Some of the major new areas of research opening up include the following:

- **Clean coal technologies.** These technologies focus on trying to reduce the negative environmental impact of coal energy generation.
- **Nuclear power.** South Africa aims to achieve at least 9.6 GW new nuclear capacity by 2030.
- **Renewable energy technologies.**

These include biofuels such as sugar cane and maize which are used to produce biodiesel and bio-ethanol fuels. They also include solar, wind and hydro power.

- **Hydrogen and fuel cell technologies.** These technologies use hydrogen to store and move energy in a usable form from one place to another. The technologies hold great potential for job creation in South Africa because 75% of the world's reserves of Platinum Group Metals – the key catalytic material used in most fuel cells – are found in South Africa.



## Alan Brent's advice:

The field is about to explode which will lead to the establishment of a whole new sector. Decide early on if you want to be a generalist or focus on a specific type of energy technology, such as solar, thermal, wind, ocean, etc, as each of these requires different skills.

Make sure that you get relevant experience, for example, as an intern, from the outset because the field is changing fast and one needs to keep up to speed all the time. Remember, you must be willing to work with other disciplines and as part of a team.

**Job:** Sustainable energy specialist and Professor of Sustainable Development

**Where:** Centre for Renewable and Sustainable Energy Studies, Stellenbosch University, where Brent is Associate Director. He is also a part-time professor in the Graduate School of Technology Management at the University of Pretoria.

**Qualifications:** Masters degrees in Environmental Sciences and Technology Management, and a PhD in Engineering Management.

**A typical day:** At the Centre for Renewable and Sustainable Energy Studies, Brent coordinates the postgraduate masters programme in renewable and sustainable energy studies, which spans the faculties of Engineering and Economic & Management Studies. He also initiates and manages research projects undertaken by masters and PhD students and research engineers, including anything from research about policy to techno-economic feasibility studies of new renewable energy technologies.

Every day includes many meetings – with students, colleagues and external contacts on current and potential research projects. He also needs to keep up to date with scientific developments as well as publish his own research papers in between his administrative duties.

Another aspect of his work is promoting renewable energy in the private and public sectors.

**Why my job is important:** It gives me an opportunity to help establish a self-sustaining renewable energy sector in South Africa and the region.

**Why did you choose this path?** The 'green' orientation was enticing. My career, which began in Chemical Engineering, then 'drifted' in this direction and I was hooked.

“ My job is extremely dynamic and no two days are the same. That's exciting.

One needs to juggle many balls at the same time, which can become extremely challenging. ”

Alan Brent

**Where can sustainable energy specialists work?**

Just about anywhere – the private sector, including big corporates and smaller consultancies, as well as government agencies.

**What you need to get there:**

**School subjects:** Mathematics and Physical Science are essential.

**University qualifications:** A degree in Engineering and one or more postgraduate degrees in Technology/ Engineering Management, Environmental Engineering or Sustainable Development.



## What is a utility-scale wind energy facility?

This is basically a wind farm. At the utility scale, a wind farm consists of a number of wind turbines – sometimes as many as hundreds – which transmit electricity to other users through a transmission system. It is expected that the first commissioning of commercial wind energy projects will happen in South Africa in 2014.

### What you need to get there:

#### School subjects:

Mathematics and Physical Science are essential.

#### University qualifications:

There is no one degree to be a developer, but if you are interested in renewable energy, a degree in a relevant Engineering or Science subject such as Environmental Science, Atmospheric Science, Town and Regional Planning, Electrical or Civil Engineering will be useful. In addition to a relevant scientific or engineering qualification, business- and project management-related qualifications or an MBA are also desirable.

### Methuli Mbanjwa's advice:

“ One of the biggest challenges of my job is problem-solving when there are no precedents! A multi-disciplinary approach – applying expertise from a lot of different areas – is needed to solve these problems. Research the industry and the discipline and identify areas of work that are of most interest to you and then focus on those. Build your knowledge and skills base in order to be able to make a meaningful contribution.

You will also need to have excellent communication skills, enjoy solving problems, and appreciate attention to detail. You must be willing to work as a team. Work hard, work smart and work with passion. Grab opportunities that come your way with both hands.



### Job: Wind energy project developer

**Where:** G7 Renewable Energies, a Cape Town-based wind energy developer where Mbanjwa is a project manager

**Qualifications:** MTech (Chemistry), Post-graduate Diploma in Business Administration, MBA

**A typical day:** Mbanjwa coordinates all the stages in the development of the utility-scale wind energy projects (see information box) undertaken by G7 Renewable Energies.

This means he coordinates feasibility studies to identify the best site for wind turbines and the amount of wind likely to be received on each site. He then oversees the applications for permits and authorisation to build the turbines, the design of the site, and environmental impact assessments. In addition to technical matters, Mbanjwa also deals with legal matters, finances, government relations and stakeholder management.

Every day is different but involves intense focus on project schedules, and lots of meetings with the team and stakeholders. Regular reports are prepared and Mbanjwa undertakes a number of site visits. He also meets with specialists in engineering design, environmental studies and geotechnical studies – all of whom provide expertise on the various projects.

**Why my job is important:** I really want to see our first wind farm succeed and provide electricity to the national grid. My job gives me an opportunity to be personally involved in the early stages of renewable energy deployment in South Africa and help to kick-start the renewable market. To have a positive impact on those around me and upon South Africa is my personal definition of success.

**Why did you choose this path?** While working in the analytical chemistry discipline, I became extremely curious and interested in renewable energy development as a solution to the problems of climate change. I eventually made a decision to move into the field. It's very exciting to be working with a passionate, enthusiastic and motivated team of young entrepreneurs who really want to make a difference in the South African wind energy industry.

### Where can wind energy developers work?

Opportunities are vast, including in the private sector with various international and local companies. Tertiary and research institutions such as the CSIR and the South African National Energy Research Institute (SANERI) are also involved in research related to renewable energies. Corporates such as banks and development finance institutions also need relevant expertise for technical aspects of project financing.



Photo courtesy of MEC Black Manufacturing



# Climate – global challenge

Climate change is an area of cutting-edge science that is also at the top of the political agenda.

It has been described by the United Nations head as the “major, overriding environmental issue of our time, and the single greatest challenge facing environmental regulators.”

A growing crisis, climate change is set to affect economic, health and safety systems, food production, security and other issues – collectively known as “global change”.

Recognising the challenge, the world’s nations are already implementing policy and conducting research on climate change.

Efforts can be divided into two main fronts:

- Limiting the impact of climate change, including setting targets to reduce emissions;
- Adaptation or planning ahead so we can cope better with the changes.

In order to tackle climate change immense amounts of research, observation and monitoring around the world are required.



# What's happening in South Africa?

South Africa has set a vision for 2018 to be a world leader in climate science and in response to climate change.

As part of its Global Change Grand Challenge, the country has already invested significantly in infrastructure, including an internationally recognised centre of excellence with climate change and modelling capability.

Four major “knowledge challenges” within the Global Change Grand Challenge, and in which SET graduates can potentially carve an exciting career, include:

- **Understanding a changing planet**  
– this involves understanding how our ecosystems are changing, where the changes are happening and how quickly.
- **Reducing the human footprint**  
– unlocking new more sustainable ways to support and improve human wellbeing and quality of life for current and future generations.
- **Adapting the way we live**  
– changing the way we live to slow down or reverse the effects of the changes.
- **Innovation for sustainability**  
– finding creative solutions.

## What is climate change?

Climate change is a significant and lasting change in weather patterns over long periods of time ranging from decades to millennia.

In 2007 scientists from around the world confirmed the link between greenhouse gases and an increase in the Earth's temperature, i.e. global warming.

Greenhouse gases have grown by 70% between 1970 and 2004.

It is anticipated that rising temperatures, increased carbon dioxide emissions and rising sea levels will continue, and extreme weather conditions – including both droughts and floods – will increase in frequency, affecting biodiversity and agricultural production.

In Africa, the spread of diseases such as malaria is expected to increase, but all countries are likely to be affected in some way. Thus a global effort is required to address climate change.

**THERE ARE LOTS OF WAYS FOR YOU TO BE A PART OF THIS EFFORT.**

Most of these challenges fall within the multi-disciplinary field of Earth systems, which embraces traditional disciplines like chemistry, physics, biology, mathematics and applied sciences.

In Earth systems science, the Earth is seen as an integrated system made up of inter-dependent spheres. Earth systems science aims to understand the physical, chemical, biological and human activities that shape the past, current and future states of the Earth and to provide a basis for understanding the world and achieving sustainability.

Earth systems science offers a wide variety of career paths to choose from, including oceanography, solar radiation, volcanology, weather modelling, and hydrology. If you choose to pursue a career in this field, your biggest challenge is likely to be the choice of research areas on offer.

If research is not your particular interest, consider combining environmental science or technology with business training – a combination of skills many large corporates are now looking for to help reduce their carbon footprint.

Communication of research is also vital and offers another way to contribute to the field, especially when combined with administration or drafting or enforcing legislation.



## Job: Environmental scientist

**Where:** Department of Environmental Affairs in Pretoria, where Nkambule is a Control Environmental Officer.

**Qualifications:** Bachelor of Environmental Science, BSc (Honours) in Geography, Masters in Environmental Science

**A typical day:** Nkambule's job is to support the Environmental Management Inspectorate (EMI) or Green Scorpions, as they are more popularly known. Every day, he applies his in-depth knowledge of environmental legislation in order to establish whether infringements have taken place and to refer complaints to the relevant departments. He also follows up on previous complaints to get updates on the investigations and give feedback to complainants. Working as a part of a team, he helps to collate and analyse environmental crime data and produces monthly, quarterly and annual reports on all environmental complaints handled by the inspectorate.

### Why my job is important:

Natural resources are the source of everything required for human survival. Managing these resources is vital, and playing a role in that process provides immense personal satisfaction.

### Why did you choose this path?

It was actually a career adviser who suggested I study Environmental Science and that's how I became involved in the field, to which I am now strongly attached. I think it's relevant also that I had a love for helping others.

### Where can environmental scientists work?

A diverse range of organisations in the private and public sectors, including non-governmental organisations.

### What you need to get there:

School subjects: Mathematics, Physical Science, Geography and Biology are important.

University qualifications: Environmental Science degree or Environmental Management degree at undergraduate level. A post-graduate qualification is advantageous.

## Who are the Green Scorpions?

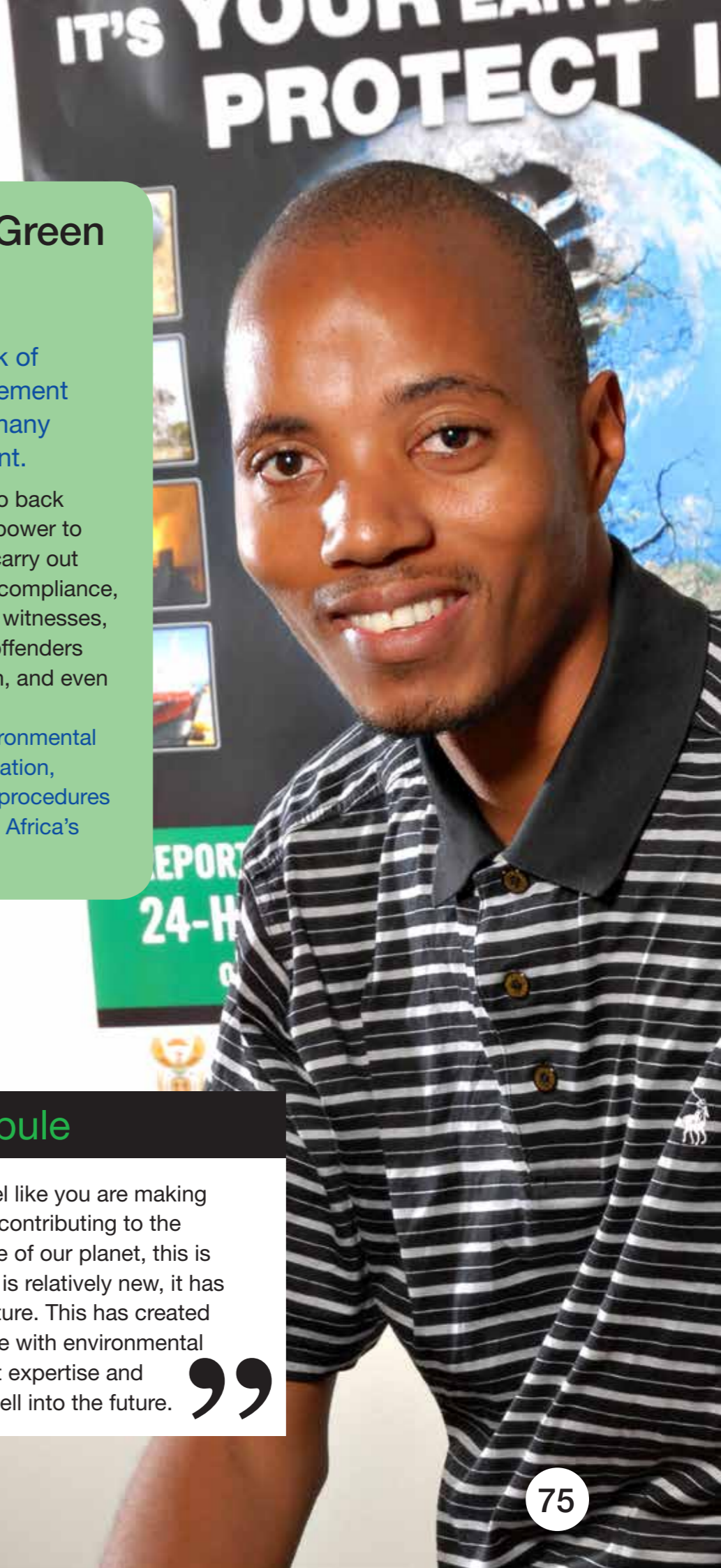
The Green Scorpions are a national network of environmental enforcement officials drawn from many spheres of government.

With environmental law to back them up, EMIs have the power to pursue green criminals, carry out inspections to check for compliance, seize evidence, question witnesses, issue notices that force offenders to comply with legislation, and even make arrests.

Across the network, environmental officials can share information, experience, training and procedures in order to enforce South Africa's environmental laws.

## Caesar Nkambule

“ If you want to feel like you are making a difference and contributing to the sustainable future of our planet, this is a wonderful field. Since it is relatively new, it has a bright and promising future. This has created a great demand for people with environmental science and management expertise and this is likely to continue well into the future. ”





## Job: Climate change geographer

**Where:** The CSIR's Natural Resources and the Environment Unit, where she is principal researcher in the Climate Studies, Modelling and Environmental Health Group.

**Qualifications:** PhD focusing on climate change and grazing systems in the Karoo; followed by a National Oceanic and Atmospheric Administration (NOAA) Global and Climate Change Postdoctoral Fellowship at the International Research Institute for Climate and Society (IRI) at Columbia University, co-hosted by the Pennsylvania State University

**A typical day:** Van Garderen's job is to gain a better understanding of what is causing climate change and how it will affect people's lives. She does this by analysing climate change projections for South Africa and the African continent. She also models impacts for key sectors to predict specific future effects.

She is involved in developing national and regional climate change strategies and policy in Africa.

On a typical day, Van Garderen will usually dedicate the morning to either writing, editing or analysis and then spend the afternoons writing proposals and reviewing the work of staff and the masters and PhD students under her supervision. Her work also involves attending meetings, handling administration and responding to queries.

**Why my job is important:** Climate change is quite possibly one of the most exciting fields in the world to work in. One of the wonderful things about working in South Africa is the extent to which we are called upon as scientists to inform government. This is exciting, but also challenging.

**Why did you choose this path?** Part of my childhood was spent in the farming community of the arid eastern Karoo, surrounded by relatives and friends discussing drought and rain. Climate change started to emerge as a major issue when I was studying for my BSc honours degree in Environmental and Geographical Science at the University of Cape Town. Coupled with some inspiring teachers and mentors along the way, this resulted in climate and managed ecosystems becoming my passion.



To pursue this career, you need drive, creativity, the ability to work independently and to prioritise. You need to be flexible and able to multitask at times. At other times, you need to be able to focus exclusively on one task.

– Emma Archer Van Garderen

## Emma Archer Van Garderen

“ With the right qualifications and a clear sense of what you want to do, the sky really is your limit! Get your qualifications through to PhD level and then get a good postdoctoral position with a trusted mentor in your specialist field. Learn how to manage projects and budgets, and get used to multitasking. Decide upon the balance of research and operations/strategy work you want to undertake. This choice will help you find appropriate positions as you go forward. ”

## Where can environmental scientists work?

Research organisations, universities and the private sector, both in South Africa and overseas, as well as at multinational organisations.

## What you need to get there:

School subjects: Mathematics, Physical Science and Geography are important.  
University qualifications: An undergraduate and honours degree in Geography and/or Ecology, Environmental Science, Hydrology and Climatology, followed by a PhD on a climate research topic specific to the area in which you wish to specialise.



## The big challenges:

Understanding human health from an environmental perspective is fascinating and never boring. One of the biggest challenges is finding middle ground between those investigating human health from an environmental perspective and those who are conventional medical professionals.

Another challenge is ensuring you are a good researcher, lecturer and manager in equal measure.

### What you need to get there:

#### School subjects:

Mathematics, Biology and all Science subjects

#### University qualifications:

An undergraduate degree in Science which has enough content on the ecology of vectors and parasites, such as Biology. At postgraduate level, choose Climatology or a similar environmental subject. A PhD is vital and should include a project that integrates parasitological/entomological content with climate change. It is also advisable to do a diploma in Public Health. Additional modules in GIS and remote sensing are necessary to improve your special analytical techniques.



### Jane Olwoch

“ Choose your subjects and courses carefully and do your best, aiming for 100%. Remember, when looking at human health from the perspective of the environment, the only constant is ‘change’.”

### Job: Climate change specialist – human health

**Where:** The University of Pretoria’s Department of Geography, GIS and Meteorology and Centre for Environmental Studies, where she is a senior lecturer.

**Qualifications:** PhD in Zoology, MSc in Biology, BSc (Honours) in Biology and BSc (Botany/Zoology)

**A typical day:** Simply put, Olwoch investigates the impact of environmental and climate change on human health. Scientists have discovered that organisms which cause disease can flourish in ecosystems that are degraded or weakened by climate change or unsustainable human activity. Thus the advent of climate change also means a possible increase in infectious diseases.

At the moment, Olwoch is looking at the relationship between climate change and cholera and malaria in Limpopo Province.

Her days are filled with lecturing, researching and supervising postgraduate students. She also administers courses, meets with staff, and manages degree programmes. As an academic, she is also required to attend postgraduate seminars and conferences where she presents her research findings.

**Why my job is important:** The environment contains many answers to why we get sick, why medicines don’t work all the time and why diseases occur in certain places and at certain times and not others. In addition, helping students to complete their degrees and to secure employment which will benefit the country, is important work and very gratifying.

**Why did you choose this path?** When I was at primary school, our herd of cattle was infested with ticks and tick-borne diseases at certain times of the year and not others. This inspired me to study insects. I also missed a lot of school during the wet season because I suffered from malaria. Together, these experiences motivated me to study Zoology and I chose Entomology (the study of insects) and Parasitology (the study of parasites) as my extra-optional subjects.

**Where can climate change specialists with a focus on human health work?** Climate change will affect many social and economic systems and as a result there are many institutions with sustainability units where you can be employed, as well as banks, government departments, universities, research organisations and international organisations.



# Hydrogen and fuel cell technology

## An energy solution for the 21st century?

As discussed in an earlier section, the demand for energy is growing throughout the world and pressure is mounting to find alternative, renewable sources of energy.

Hydrogen and fuel cell (HFC) technology offers an opportunity to develop an energy system based on safe, clean and reliable alternative energy sources by using hydrogen to store and deliver energy.

Hydrogen is the most abundant element in the universe – 90% of all the atoms in the Universe are hydrogen atoms. Although not itself an energy source, it is an energy carrier which means it can store and move energy in a usable form from one place to another. It will enable both power and energy to be produced cleanly and efficiently from alternative sources of energy.

## What is a fuel cell?

Fuel cells convert chemical energy into electrical energy (electricity) using hydrogen or other fuels and oxygen from the surrounding air.

In simple terms, a fuel cell operates like a battery, except that it does not run down or need re-charging. Hydrogen fuel cells use a quiet, efficient, non-polluting process that can be repeated over and over and converts the hydrogen's energy to electricity with heat and pure water as the only emissions.

The three basic elements of a fuel cell are the catalyst-containing anode and cathode, and the electrolyte.

Fuel cells work by reverse electrolysis. Instead of splitting water molecules into hydrogen and oxygen, they combine hydrogen and oxygen to form water and release the energy content.

## Applications of HFCs

HFCs can potentially be tailored for any use, ranging from the powering of cell phones to cars and houses and even neighbourhoods. They are especially useful in remote locations, such as weather stations, nature reserves, military operations or even submarines and spacecraft.

HFCs have the potential to replace the internal combustion engine in vehicles, radically changing the way we think about transportation.



# What's happening in South Africa?

Hydrogen and fuel cell (HFC) technology is considered by the South African government to be a “frontier” science and technology platform. It is considered a potential alternative future energy system which could be integrated with other renewable energy technologies, such as solar cells, for more remote applications.

The Hydrogen and Fuel Cell Technology Research, Development and Innovation Strategy was approved by the Department of Science and Technology in 2007.

The goal of the 15-year-long strategy – known as HySA – is to establish a South African HFCT industry that captures a significant share of the global energy market.

The South African government is driving the research and development on HFCs and related technology for three main reasons:

1. SA has an abundance of Platinum Group Metals (PGMs) which are the key catalytic materials used in most fuel cells. This provides great potential for socio-economic benefits to be obtained from these natural resources due to the increased global demand for PGM products. SA's national target is to supply 25% of the PGM content in the form of value added products to the international fuel cell market by 2020.
2. Development of the sector to the point at which South Africa becomes an international supplier will lead to significant job creation.
3. The development of HFC technology as a viable alternative renewable energy source is essential to reduce carbon dioxide and greenhouse gas emissions and thus help the country meet its commitment to global targets.

## HFCs: A future reality?

A lot of research and innovation is needed before fuel cells become a practical alternative to current energy production methods.

Some of the specific challenges facing the industry include:

- The high cost of producing fuel cells and related components;
- The need for new storage and distribution strategies for hydrogen gas;
- Developing greater durability of fuel cell powered systems;
- Addressing the potential dangers in using a flammable gas such as hydrogen;
- The need for more links between industrial manufacturers in South Africa and researchers;
- Developing sufficient human expertise to make it a reality in the allocated time span.



Three “Centres of Competence” or CoCs have been established by the government to implement the HySA strategy. They are:

**1. HySA Catalysis** – focusing on catalysts and catalytic devices for fuel cells and hydrogen production, co-hosted by the University of Cape Town and MINTEK.

“South Africa is endowed with immeasurable mineral riches; converting these into high technology products will create a prosperous future with high-quality jobs for many South Africans.” – Dr Olaf Conrad, Director, HySA Catalysis.

**2. HySA Infrastructure** – focusing on technologies for hydrogen generation and production, storage and distribution, co-hosted by the North-West University and CSIR.

“What is so exciting about this technology is that by using our natural resources, everyday products can be made that are not only environmentally friendly, but can ultimately impact on and improve the lives both of South Africans and of millions of people around the world.” – Dr Dmitri Bessarabov, Director, HySA Infrastructure.

**3. HySA Systems** – focusing on systems integration and technology validation, hosted by the University of the Western Cape.

“Hydrogen and fuel cell technologies will have an enormous impact across all energy markets around the world. South Africa will be the catalyst for this revolution in sustainable technologies by providing first-class technologies, products and skilled researchers.” – Professor Bruno G. Pollet, Director, HySA Systems.

### You can play a role:

In the development of any new technology, people with relevant qualifications and expertise are needed – in particular, South African postgraduates with relevant degrees in Science and Engineering. Developing the necessary human skills and expertise at various levels is essential to the sustainable growth of the sector.

HySA has set up a **Hydrogen Cell Development (HCD) programme** to increase the number of South African students in the postgraduate pipeline, ranging from masters to postdoctoral level. Through this programme it is promoting collaborative and interdisciplinary research and is developing an internationally competitive research training environment. National internships and mentor programmes are also part of this programme.

The Department of Science and Technology’s HySA Public Awareness Platform is hosted by the South African Agency for Science and Technology Advancement (SAASTA), a business unit of the National Research Foundation.

For more information, visit [www.hydrogen.org.za](http://www.hydrogen.org.za) or [www.saasta.ac.za](http://www.saasta.ac.za) or contact SAASTA on 012-392 9376.



## Job: Hydrogen and fuel cell specialist

**Where:** HySA Systems, based at the South African Institute for Advanced Materials Chemistry (SAIAMC) at the University of the Western Cape, where he is Programme Manager of the Combined Heat and Power Programme.

**A typical day:** The Combined Heat and Power (CHP) programme aims to develop customised fuel cells for use as a CHP source supplying decentralised power and heating for buildings and industries. CHP systems are popular in colder countries where heating is required more often. Thus the CHP programme is aimed at meeting the needs of the **global market**. Pasupathi coordinates all the projects within the CHP programme, ensuring work is completed on time and reporting back to the funders. His overall goal is to ensure the CHP project is a success and to bring locally developed products to the international market. He also undertakes his own research, supervises students and lectures honours students.

A typical day will involve meetings with project groups, collaborators or researchers and overseeing some of the Research and Development work. He also fits in the writing of project proposals or reports and checks some of his colleagues' research manuscripts in order to ensure some of the research coming out of the programme is published.

**Why my job is important:** This work gives me the opportunity to bring something new and advanced to the community and the South African economy through research and development.

**Why did you choose this path?** I loved Chemistry throughout school, especially the practicals involving titrations and preparing organic compounds which require close and precise attention to detail. After completing my master's degree, I carried out a project on fuel cells which I enjoyed so much I decided to pursue a career in this area.

## Where can hydrogen fuel cell experts work?

Internationally, there are several companies and research institutions recruiting HFC experts and they are found easily by searching for this discipline on the internet. Locally, HFC experts can find work at the three national Centres of Competence (see above) and various tertiary institutions and science councils working in this area.

## What you need to get there:

**School subjects:** Science (mainly Chemistry and Physics) and Mathematics.

**Qualifications:** At university, take a degree in Chemistry, Physics or Chemical, Mechanical or Electrical Engineering. A postgraduate qualification is highly recommended.



## Sivakumar Pasupathi

“ To succeed you need motivation, perseverance, dedication and attention to the smallest details.

The job opportunities in this sector are increasing significantly globally, with several new companies being established. Due to its extensive PGM reserves, South Africa is also likely to attract companies to set up facilities. The potential of this technology is slowly being realised in various applications and it will soon be commercialised at mass scale. So join the sector and let's work together towards making this happen.

”



# Biotech **nology** science and life

The use of living organisms to benefit humans has reached new heights as scientists continue to make new discoveries and better understand how living things work. Biotechnology is changing the way we

- Treat our sick • Run our factories • Make our products
- Track down criminals • Protect our livestock
- Keep our environment clean • Conserve our wildlife
- Grow our plants and feed our people





# Bioeconomy

Bioeconomy can be defined as a set of economic activities relating to the invention, development, production and use of biological products and processes.

**Did you know** that the global population is expected to reach **8.3 billion** in **2030**, with 97% of the growth happening in developing countries.

Developing countries like South Africa face environmental, social, and economic challenges. A growing population and an increase in incomes will result in an increased demand for healthcare as well as agricultural, forestry, and fishing products.

At the same time, climate change could worsen environmental problems by adversely affecting water supplies and increasing the frequency of drought.

Biotechnology as a field can offer potential technological solutions for the world's health and resource-based challenges. The application of biotechnology to primary production, health and industry could result in an emerging 'bioeconomy' where biotechnology contributes a significant share to economic output.

The bioeconomy could enhance socio-economic growth by bringing about benefits such as improved health outcomes, a boost in the productivity of agriculture and industrial processes, and enhanced environmental sustainability.

Biotechnology today is used in primary production, health and industry. Technologies such as genetic modification, DNA sequencing and bioinformatics have commercial uses in several application fields.

The main current uses of biotechnology in primary production are for plant and animal breeding and diagnostics, with a few applications in veterinary medicine. Human health applications include therapeutics, diagnostics, pharmacogenetics to improve prescribing practices, functional foods and nutraceuticals, and some medical devices. Industrial applications include the use of biotechnological processes to produce chemicals, plastics, and enzymes; environmental applications such as bioremediation, methods to reduce the environmental effects or costs of resource extraction, and the production of biofuels.



## Job: Wine biotechnologist and senior researcher

**Where:** The Institute of Wine Biotechnology at Stellenbosch University

**Qualification:** PhD in Microbiology

**A typical day:** Laboratory work is the main focus. However, during harvest time you will find Dr Setati in the vineyards picking grapes from which she makes wine - all for her research! On other days she may have research group meetings, management meetings and student meetings.

Dr Setati supervises postgraduate students from honours to PhD level. This requires time and patience especially when students get unexpected results in the lab and she has to figure out what could have gone wrong. So, it is not your typical day-job!

**Research focus:** The focus of Dr Setati's research is to understand how different farming methods and viticultural (wine farming) practices affect the quality of wine produced. Microorganisms are essential in the wine-making process. Therefore, different methods affect the diversity of microorganisms found on the grapes.

In addition, certain pruning strategies reduce the evaporation rate from vineyards, meaning that less irrigation is required. This saves water. This research generates knowledge about how farming methods affect the vineyard ecosystem and will in future help farmers to make more informed decisions about their choice of farming method.

**Why my job is important:** Biotechnology is a cross-cutting activity, and supplies cutting-edge tools for future developments in science, agriscience and the wine sciences. Most scientific investigations today, even in the traditional wine sciences, require molecular tools to provide new insights. Biotechnology has the biggest long-term innovation potential.

**Why did you choose this path?** I was fascinated with microorganisms and wanted to understand their impact on human life.

“ With growing consumption of wine and the constant need for improved products to be able to compete with other wine-producing countries, I believe that wine biotechnology as a career will always be relevant. In addition, wine biotechnology contributes to the development of commercial products and is therefore important for innovation in South Africa. ”

**Dr Evodia Setati**



biotechnology

**Where can wine biotechnologists work?**

- The wine industry
- Diagnostic laboratories
- Police forensic units
- Research institutes such as the Centre for Scientific & Industrial Research (CSIR) and the Agricultural Research Council (ARC)
- Academic institutions

**What you need to get there:**

**School subjects:** Mathematics, Life Science, Physical Science

**University qualifications:** Wine biotechnology is only offered at postgraduate level at Stellenbosch University. Students with degrees in Mathematics, Computational Science, Microbiology, Biochemistry, Genetics, Food Science, Chemistry, Chemical Engineering, Viticulture, Oenology (science of wine-making) and Plant Biotechnology are accepted.





### Where can medical biotechnologists work?

- Academic institutions
- Research institutions, including universities and medical research groups such as the Medical Research Council (MRC) and the Council for Scientific and Industrial Research (CSIR).
- Biotechnology companies
- Multinational pharmaceutical companies

### What you need to get there:

#### School subjects:

Biological Science, Physical Science, Mathematics

#### University qualifications:

Bachelor of Science with a focus on Medical Sciences thereafter, BSc Honours, MSc and PhD

### Dr Marnie Potgieter

“ I am in the very fortunate position of doing what I love. I enjoy the knowledge that I am able to accumulate through my research. I look forward to applying the knowledge and to translating the stem cell research that we do in the clinic. ”

**Job:** Medical biotechnologist

**Where:** Department of Immunology at the University of Pretoria

**Research focus:** Stem cells

**Qualifications:** PhD in Anatomy

**Why my job is important:** Stem cell research has the potential to allow for the development of effective treatment strategies to address a range of current health problems in South Africa.

It is my aim to be part of the team leading cell therapy in South Africa and on the African continent.

Stem cell technology is a fast-growing field all over the world and is set to offer an increasing number of exciting and sustainable career opportunities. As it grows, the field will need more well-trained scientists and biotechnologists to sustain the growth and to translate the research into other avenues, such as commercial, clinical and academic.

**A typical day:** Most time is spent in the laboratory, interspersed with documenting results in research papers and meeting with the research group.

### Why did you choose this path?

I have a strong passion for people who are disabled by muscular and neuromuscular disorders. I also received enormous encouragement and inspiration from my mentor, Professor Michael Pepper.



### Where can biofuels researchers work?

- Academic institutions
- Research institutes such as the Council for Scientific and Industrial Research (CSIR) and South African National Energy Research Institute (SANERI)

### What you need to get there:

School subjects:  
Biological Science, Physical Science, Mathematics and English

University qualifications:  
Bachelor of Science with postgraduate studies focusing on biofuel production

## Trudy Jansen

“ The Earth is running out of fossil fuels (coal, oil/ petroleum and natural gas) and alternative sources of fuel are urgently needed, not only to satisfy demand for fuel but to reduce the carbon footprint that results from conventional energy use and its role in climate change. ”



### Job: Biofuels researcher

**Where:** Department of Microbiology, Stellenbosch University

**Qualification:** Jansen is studying towards a PhD in Microbiology

**Research focus:** Jansen’s work is focused on the genetic engineering of a bacterial strain which can be used in biofuels production. This organism will convert biomass such as plant matter and organic waste to ethanol, an energy source.

“Most of the opposition to biofuels, especially in Africa, is that they are seen as using food and feedstock as a resource. But my research focuses on second generation biofuel production, so that biomass other than food or feedstock is used. My research thus negates the fuel versus food debate and is integral to South Africa and Africa’s success in biofuel production.”

**A typical day:** Most time is spent in the laboratory, interspersed with documenting results, and meeting with the research group. New developments are taking place rapidly in the field, so Jansen has to keep abreast of these and their impact on her own research. She also has to determine if her biofuels production at a small scale in the laboratory will be effective on a large industrial scale.

**Why did you choose this path?** The biofuel field is dynamic and exciting. You have the opportunity to do basic science with the possibility of directly impacting on the sustainability of life. Being part of a multi-disciplinary global focus brings tremendous opportunities. Interfacing with an intellectually diverse group of people is stimulating, rewarding and exciting.





**Job:** Medical Science researcher

**Where:** Africa Centre for Health and Populations Studies at the University of KwaZulu-Natal

**Qualifications:** Studying towards a master's degree in Medical Sciences

**Research focus:** Pillay's work focuses on HIV anti-retroviral treatment (ART) in children in rural KwaZulu-Natal. She uses bioinformatics – a combination of maths, statistics and information technology – to help analyse her data.

**Why my job is important:** There is a vast amount of research being conducted in infectious (HIV, tuberculosis, malaria) and non-infectious (cancer, diabetes) diseases. Bioinformatics is essential for analysing the vast amounts of data that this research generates. The field of bioinformatics is still growing and expanding in South Africa and advances in information technology will lead to more powerful tools for scientists to execute their work more effectively and keep patients healthy.

**A typical day:** Most time is spent in the laboratory, interspersed with documenting results and meeting with her supervisor.

**Why did you choose this path?** My research provides me with knowledge about how to effectively manage patients who are currently failing in their ART treatments. This means I am able to help patients living with HIV to lead better and healthier lives.



**What is bioinformatics?**

This is a field which combines two formerly independent fields – **molecular biology** and **computer sciences**. There is a need to have a good understanding of both fields, depending on your focus. Bioinformatics researchers who focus on the development of bioinformatics tools need a strong background in computer sciences and a good understanding of molecular biology. Those that do more analytical work need a strong background in biology as well as a computational background.

**Where can bioinformatics researchers work?**

- Academic institutions
- Research institutions, including universities and medical research groups such as the Medical Research Council (MRC)
- Biotechnology companies
- Multinational pharmaceutical companies

**What you need to get there:**

**School subjects:** Life Sciences, Physical Science, Mathematics, Computer Science  
**University qualifications:** Bachelor of Science degree majoring in Medical Sciences, Mathematics/Statistics, Biological Science or Computer Science

**Suneshree Pillay**

“ The field of bioinformatics is evolving quickly and it is important to keep abreast of technological developments. This will enable users to take advantage of the latest analytical tools to be able to answer some of the most challenging research questions facing mankind today. ”



# Nanotechnology



## The technology of the future

Nanotechnology is known as the technology of the future. It is one of the most exciting areas of research that may lead to some of the greatest technological advances of the 21st century.

Although not a separate technology on its own, it can provide new tools for the advancement of existing technologies and has the potential to touch almost all areas of human existence.

Nanotechnology can be used to develop faster computers, amazing new materials or tiny robots. Scientists also believe that nanotechnology has the capacity to solve some of the world's most serious health, environmental and energy problems.

## What is nanotechnology?

Nanoscience and nanotechnology are very broad areas of science and technology which deal with the manipulation of matter at the level of atoms and molecules. When manipulated at this level, matter can show different physical properties. Soft materials can display extreme hardness and strength. Opaque materials can become transparent while other elements that might ordinarily be inert can become chemically reactive.

Nanoparticles also have much more surface area, so they are excellent catalysts (substances that speed up chemical reactions).

Nanotechnology offers a new wave of innovation based on something really small, but smarter than anything before.

### Did you know?

The prefix “nano” comes from the Greek word nanos meaning ‘dwarf’.



# What's happening in South Africa?

In a country like South Africa, nanotechnology holds enormous potential to offer better healthcare, access to clean, safe water, and enhance the production, storage and distribution of clean energy.

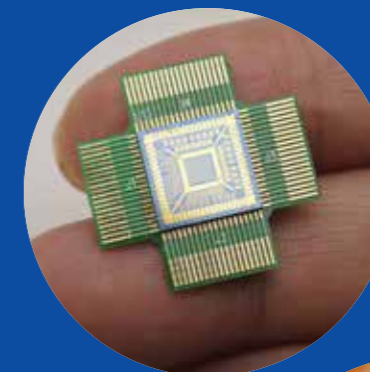
It is anticipated that in less than five years' time, up to 15% of manufactured products will incorporate some form of nanotechnology. Therefore, many countries, including South Africa, are investing in this technology in order to position themselves for the future. Although still in its infancy in South Africa, most South African universities and scientific institutions are conducting research and development in nanotechnology. The scope and application of nanotechnology is overwhelming. It is one of the most diverse fields and the hottest topic for many scientists and engineers.



## Some current applications of nanotechnology:

### Computer Science:

Instead of cutting and processing thin slices of silicon to make computer chips, engineers work with individual molecules to build computer processors and memories. Putting such molecules together would create a tiny chip that could hold an enormous amount of memory. You could end up with a supercomputer the size of your cell phone.



### Medicine:

Nano devices could go inside the body to deliver drugs exactly where needed, or perform delicate operations.

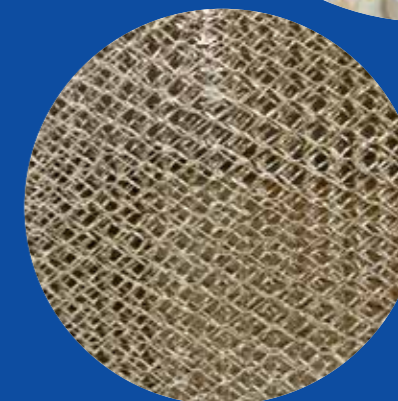


### Energy:

A nanoscale coating on glass could help turn the sun's energy into electricity. Nanotech could also help make light bulbs more efficient.

### Materials and coatings:

Already, a company called Nano-Tex makes fabrics with different kinds of "molecular hooks" that can repel stains, eliminate wrinkles, or shed water. In the future, nanotech-enhanced clothes could respond to the weather, to warm you up or cool you down. The US Navy is using nanotech coatings on their submarines to keep sea creatures off and reduce corrosion. Other nanomaterials could lead to lightweight airplanes and other types of equipment.



### Sport:

Nanotechnology is big news in sport. Scientists are already using nanomaterials to make top-of-the-range equipment with enhanced properties. Shock-absorbing shoes give softer landings, balls keep their pressure for longer game play, and stronger tennis rackets and golf clubs made with nanomaterials can deliver more powerful, straighter shots.





## Jobs, Jobs, Jobs ...

Worldwide, nanotechnology is expected to provide nearly two million jobs by 2015, with the United States, Japan and Europe leading the pack.

The interdisciplinary nature of nanoscience and technology allows for study in many fields such as Chemistry, Biology, Physics, Engineering, Environmental Science, Agriculture, Medicine, Law, Business, Pharmacy, Social Science (e.g, Ethics). This has resulted in a range of new jobs worldwide.

## How do I pursue a career in nanotechnology?

To pursue a career in nanotechnology, you must have a **postgraduate qualification** – either a master's degree (MSc or MTech) or a doctoral degree (DSc or DTech) – related to nanotechnology.

The first step towards a career in nanotechnology is doing well at school in **Mathematics and Sciences. Aim for a mark above 60%.**

You should then enrol for and obtain a BSc at a reputable tertiary institution. Subsequent entry into postgraduate study will depend on your undergraduate performance and the individual institution's entry requirements. Almost all science departments at South African universities introduce nanomaterials at second or third-year level in some of their existing subjects.

At present, no South African tertiary institution offers a degree specifically in the field of nanotechnology. The equivalent of such a degree is a master's or doctoral degree in any of the physical sciences or engineering fields or pharmacy or medicine where the degree involves research on the exploitation of nanostructured material.

## Where can you study?

Most universities in South Africa offer postgraduate degrees based on research projects in nanotechnology. Many of these universities conduct research in partnership with industries (such as Sasol, Element 6, Rand Water, Eskom), research centres (such as the CSIR, Mintek, NECSA) and other universities around the world. Details of research topics at master's and PhD level can be obtained by visiting the websites of the institutions on the Internet.

For more information on nanotechnology, visit the website of the Nanotechnology Public Engagement Programme (NPEP) at [www.npep.co.za](http://www.npep.co.za). Funded by the Department of Science and Technology, the programme aims to promote a fact-based understanding of nanotechnology through awareness, dialogue and education. For more information on bursaries, scholarships and research programmes for nanotechnology, turn to page 137.

## Are you suited to a career in nano-technology?

In South Africa, nanotechnology is mostly a research field, where new structures are discovered and the properties of nanomaterials studied. In order to study nanotechnology, you need to have a good background in Physics and Chemistry. Mathematics definitely gives you an added advantage. Candidates should have inquiring minds with sound analytical skills and an aptitude and passion for research.





# A career in research

## A voyage of discovery

**Being a researcher is similar to being an explorer or an inventor – you are always striving to create or discover new things. It is therefore a very exciting career, but one which often involves a lot of hard work and long hours before results are produced.**

### What is research?

Research is the investigation of a subject with the ultimate aim of producing new knowledge.

As a researcher, you will work at the cutting edge of your field, designing new research techniques, performing experiments or developing models and theories in order to produce new knowledge.

Research builds upon knowledge that already exists in the world and has been generated by others. To become a researcher, therefore, means becoming part of a national or even global network of people with specialised knowledge.

The research process involves the use of valid, reliable methods conducted in a logical, organised and planned way. Research results are valid if they successfully measure what they are supposed to measure and are reliable if they produce the same results each time an investigation is done under the same conditions.

## Quick check: Is a career in SET research for you?

Ask yourself the following questions:

- Have you dreamed about being the first person to discover something or invent something new?
- Do you like to ask a lot of questions?
- Do you like to solve problems?
- Are you able to work on your own for long periods?
- Do you like attention to detail and working through things systematically?
- Are you self-motivated?

If the answer to most of these is yes, you should consider a career in research.

Read on ...







There are two kinds of research: basic and applied research, both of which are important.

- **Basic research** – sometimes referred to as “pure” or “blue sky” research – is experimental or theoretical. It explores the fundamental principles of science. Because basic research is done without a focus on its usefulness or application, it can be risky and expensive.
- **Applied research** – this is carried out specifically to solve a problem or address certain needs or applications. This kind of research is very important in a country like South Africa which is in need of thousands of researchers to address the many problems we face.

By international standards, the South African research community is relatively small at around 20,000 individual researchers. This limits networking opportunities, but at the same time offers South African researchers the chance to make a big impact.

## How to become a SET researcher

Internationally, a doctoral degree is regarded as a basic requirement for a career in research. This means that to become a researcher, you will need to attend a university or university of technology and attain the following qualifications:

- 1. Bachelor’s degree (BSc).** This is usually a three-year degree which provides basic understanding of a SET field. It must be followed by a one-year honours degree. Alternatively, you can take a professional degree such as a BEng (four years) or MBChB (Medicine, six years). Students are usually required to do a small research project in the honours degree or final year of a professional degree.
- 2. Master’s degree (MSc).** This is either a one-year or two-year (full-time) programme which requires students to carry out research which is rigorous, but does not necessarily produce new knowledge. Like an apprentice, one of the most important tasks of the master’s student is to learn to use the tools – the research methods – relevant to your chosen field.

As a master’s student you can expect a lot of support and guidance from a supervisor who will be an experienced researcher.

- 3. The doctorate (PhD).** This usually takes between three to five years of full-time study, and is often completed part-time. A PhD student must produce new knowledge that makes a contribution to your chosen field. You will have a supervisor to give you guidance and support, but you will have to show much more independence in your research study. Thus the object of a PhD is to produce new knowledge and to become a competent and independent researcher. A PhD degree should result in research results which should be good enough to be peer-reviewed (by experts in your field) and published in an international or national journal.

## Where can you study?

South Africa has three kinds of universities that offer postgraduate degrees:

- **Traditional universities** – Master’s and PhD degrees
- **Universities of technology** – MTech and DTech degrees
- **Comprehensive universities** – all of the above.
- **Postgraduate degrees in Life Sciences, Physical Sciences and Mathematical Sciences** are offered at all traditional universities.
- **Postgraduate degrees in Agricultural Sciences** are offered at: the universities of Fort Hare, KwaZulu-Natal, Free State, Limpopo, Northwest, Pretoria, Stellenbosch, Venda and Zululand.
- **Postgraduate degrees in Geology** are offered at the universities of Cape Town, KwaZulu-Natal, Johannesburg, Pretoria, Stellenbosch, the Witwatersrand and the Nelson Mandela Metropolitan University and Rhodes.
- **Postgraduate degrees in Engineering** are offered at the universities of Cape Town, Johannesburg, KwaZulu-Natal, Pretoria, Stellenbosch and the Witwatersrand and Nelson Mandela Metropolitan University.
- **MTech and DTech degrees in various branches of engineering and technology** are offered at the comprehensive universities and universities of technology.





## Where can you work as a SET researcher?

**In universities:** If you would like to divide your time between research and teaching, then you can become a university lecturer. Universities have specialised centres or units that focus on research in key areas. Sometimes you can be a full-time researcher in a centre or unit. Postdoctoral scholarships are available in South Africa that enable newly graduated PhD students to spend a year or two gaining experience as junior researchers.

**In national facilities:** Hundreds of researchers are employed at South Africa's six national facilities to work in areas of astronomy, nuclear physics, biodiversity and ecology. The South African Biodiversity Institute also employs researchers in biodiversity at its botanical gardens across the country. Researchers in wildlife management can work for South African National Parks.

**At science councils:** These parastatal organisations include: the Agricultural Research Council, Council for Geoscience, Council for Scientific and Industrial Research (CSIR), Medical Research Council and Mintek (South Africa's national mineral research organisation).

**In government organisations:** These include the South African Weather Service and the South African Bureau of Standards. Museums also employ researchers.

**In industry:** Researchers can work for industry in a wide range of sectors, from biotechnology to chemicals, telecommunications, alternative energy, materials science and even the financial sector.

### SA needs SET researchers – NOW

As a young democracy and a developing country, South Africa faces two central and inter-related challenges: growing its economy in a sustainable fashion and improving the lives of the majority of its people.

If South Africa is to compete in today's global economy and in the context of shrinking global resources, now more than ever, it needs people with knowledge and technical expertise who can solve problems and innovate.

These imperatives – economic growth and social upliftment – provide lots of opportunities for committed SET researchers.

For example, knowledge produced by researchers may be used to produce technologies which produce clean energy, clean water and accessible health treatments.

“ There is no doubt that science and technology have changed the world tremendously and countries that excel in the sector become powerful players in the economy of the world. ”

SA Minister of Science & Technology, Naledi Pandor, 2012.

As part of the global community of researchers, your work could lead to new inventions such as smaller, more powerful computers. You might create new models or theories that could explain or predict certain natural disasters such earthquakes, or what will happen to the universe in the future.

Whether you like Mathematics, Physics, Chemistry or Life Sciences, there is a research career out there for you in South Africa.

If you like Mathematics, you can get involved in mathematical or statistical modelling which can be applied to many situations, such as the movement of animal populations, financial markets, tiny particles inside an atom or even the stars.

If you like programming, you can write computer programs and design systems to model situations and solve complicated equations.

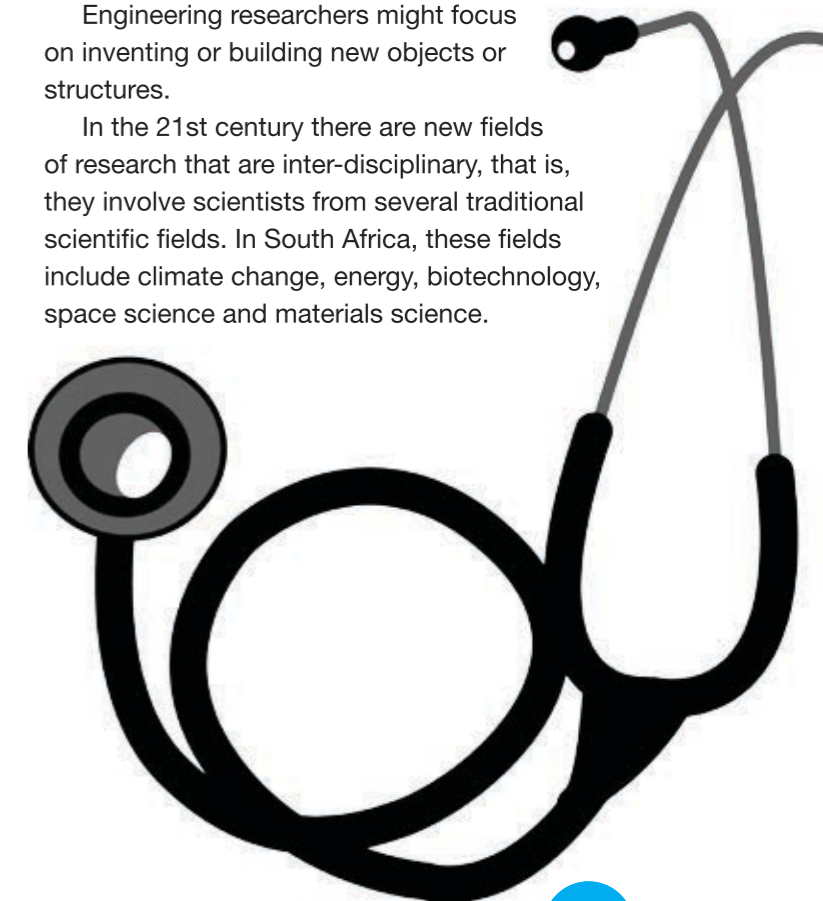
Physicists and chemists in South Africa are involved in a wide range of research, ranging from creating new materials such as those needed in solar cells or the electronics industry, to studying the behaviour of atoms, nuclei and radioactive particles, or understanding chemical processes in living organisms.

Life science researchers also work in a broad range of areas. They might seek to understand the structure and functioning of plants, animals and ecosystems at a large scale or at the level of a cell.

Earth science researchers such as geologists, climatologists and meteorologists study what happens on the Earth, under the Earth and above the Earth, including minerals, volcanoes and the weather.

Engineering researchers might focus on inventing or building new objects or structures.

In the 21st century there are new fields of research that are inter-disciplinary, that is, they involve scientists from several traditional scientific fields. In South Africa, these fields include climate change, energy, biotechnology, space science and materials science.





# [re·search]

a detailed study of a subject, especially in order to discover (new) information or reach a (new) understanding.

The South African Medical Research Council (MRC) is a science, engineering and technology institution (SETI) and was established in 1969 by an Act of Parliament. Since then we have earned our place as one of Africa's top science councils. The SA Medical Research Council (MRC) is the leading health research organisation in South Africa.

## OUR VISION

Building a healthy nation through research

## OUR MISSION

To improve the nation's health and quality of life through promoting and conducting relevant and responsive health research

## OUR HEALTH RESEARCH

The MRC has 41 Research Units, grouped according to the 14 health priorities of South Africa namely HIV and AIDS; Tuberculosis; Cardiovascular Disease and Diabetes; Infectious Disease; Crime, Violence and Injury; Cancer Public Health; Health Promotion; Women, Maternal and Child Health; Nutrition; Brain and Behaviour; Genomics and Proteomics; Environment and Health; South African Traditional Medicine.

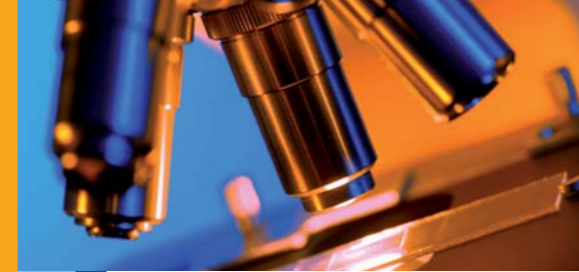
Health research is a systematic activity that continually generates new knowledge by contributing to the extension and application of the existing body of knowledge. It is this continuous generation and application of knowledge that enables the MRC to fulfill its vision of Building a Healthy Nation through Research.

Research capacity development is a process of building and enhancing the competencies of individuals and of creating supportive and enabling environments at institutions in order to bring about a greater ability to perform relevant and excellent research.

## IN THE SOUTH AFRICAN CONTEXT

### THIS INVOLVES:

- Building on our strong biomedical research base to ensure that we have the appropriate capabilities in rapidly developing fields such as genomics and bioinformatics.
- Ensuring that we develop appropriate research capabilities across the full spectrum of health research while focussing on areas with limited capacity such as public health, the behavioural sciences, ethics and human rights.
- Facilitating greater involvement of individuals from the Historically Black Universities and Technikons in health research.
- Creating opportunities for nurses and the allied health professionals to advance their research capabilities and to develop scientific leadership for health research in these disciplines.
- Developing and retaining a strong human resource base for health research in South Africa.



## MRC FUNDING

### PREDOCTORAL FUNDING

Masters  
Doctoral  
Internship for Black Scientist (Masters)  
Allied Health Professionals & Nurses  
Post MBChB  
Post BChD  
Staff Credentialling  
Overseas Doctoral  
Senior Research Training Fellowship

### POSTDOCTORAL FUNDING

Post Doctoral Scholarships - Provides an opportunity for full-time Masters and Doctoral studies in any field in the health sciences

### SENIOR POSTDOCTORAL FUNDING CAREER DEVELOPMENT AWARDS

#### RESEARCH SUPPORT

- International Conference
- National Conference
- Sabbatical Leave Grants
- Technical Assistants Grants
- Research Development Grants
- Travel Grants for Short visits

*Increasing  
Health Research  
Capacity in SA*

Development of  
appropriate research  
capabilities across all  
spectrum

Facilitating greater  
involvement of  
individuals from  
universities and  
technikons

Creating  
opportunities for  
Nurses and Allied  
health professionals  
to advance their  
research capabilities

Developing and  
retaining a strong  
human resource  
base for research  
in SA

Enhancing individual  
competencies.

SOUTH AFRICAN MEDICAL RESEARCH COUNCIL  
BUILDING A HEALTHY NATION THROUGH RESEARCH



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## Climate change research:

Many exciting research careers today are related to climate change. We need to find ways to produce electricity that do not release carbon dioxide and other pollutants into the atmosphere. As most of South Africa's energy comes from coal, **chemists and engineers** are researching ways to make coal-fired power plants cleaner and more efficient. South Africa has two nuclear power plants and is planning to build more. This means we need researchers in **nuclear science** and technology. Other **physicists, chemists and engineers** are researching alternative sources of energy, such as wind, sun, waves and thermal energy. **Biotechnologists** are looking at ways of creating biodiesel fuel from plants, including algae.



## Energy research:

A lot of energy-related research involves studying the properties of materials and designing new materials. **Materials science – which sits at the boundary of physics, chemistry and engineering – is one of the most important research areas in the world.** Many of the non-fossil fuel energy technologies need special materials. For example, photovoltaic cells will only be economically viable if cheaper materials can be designed to replace the existing silicon-based solar panels. Strong, lightweight materials are needed to make large windmills. Containment vessels for nuclear reactors are also needed that will not react with the materials involved in nuclear reactions. New materials such as LED lighting can also save energy and hybrid cars which run partly on electricity require batteries with special properties.



## Environmental science research:

South Africa's rich and diverse natural environment needs researchers who can help the country benefit economically from the environment while also preserving or enhancing it. **Life science researchers in plant and wildlife management and conservation** are vital. Their research provides knowledge for promoting sustainable ecotourism. **Biotechnology researchers** are investigating ways in which indigenous knowledge and plants can be used to develop health and pharmaceutical products. Biotechnology and **agricultural researchers** are needed to ensure the country can feed itself without degrading the land or wasting scarce water resources. Researchers are also needed to devise technologies and processes to reduce water use by industry and solve the serious problem of acid mine drainage.



## Space science research:

Space science brings together scientists from **astronomy, applied mathematics, physics and engineering.** Researchers in space science who focus on the earth investigate such things as changes in the Earth's magnetic field up to its upper atmosphere which affects communications. Earth-based observation sites and satellites orbiting earth are important tools for this research. **Astronomers** study the universe – planets, stars, galaxies and everything else, including black holes. They use powerful telescopes that detect electromagnetic radiation of different frequencies.





## Job: Antarctic researcher and microbiologist

**Where:** Professor Cowan is the Director of the Centre for Genomics at the University of Pretoria. He was formerly the Director of the Institute for Microbial Biotechnology and Metagenomics at the University of the Western Cape.

**A typical day:** As a director, Don's main responsibilities involve a lot of writing and editing. This takes the form of reports, research papers, scientific reviews, just to name a few. In addition, Don has to make time for his research groups and postgraduate students who have a variety of topics to discuss, from research results to technical issues to careers. Research is expensive, so a lot of time is also spent raising funds through grants, and then maintaining those grants.

**Why my job is important:** My work has a direct impact on the 'Farmer to Pharma' grand challenge; in other words, exploring South Africa's biodiversity and using biotechnology and local knowledge to create products from the biodiversity and strengthen the bioeconomy. The research that I undertake relates to the development and use of new methods of screening for new bio-products like enzymes and pharmaceuticals.

### Why did you choose this path?

In 1978, I visited the Antarctic as a field assistant and subsequently developed an interest in microbiology of extreme environments. I discovered that very little was known about the microbiology of the Antarctic 'dry valley' deserts. So, I developed a research programme to investigate this. The science is one of the most exciting aspects of my job. As a senior academic, I have the privilege of being able to work on a subject that fascinates and excites me, and to travel to exciting, extreme and exotic parts of the world.

### What you need to get there:

School subjects: Life Science, Mathematics, English

University qualification: A BSc degree that encompasses microbiology, genetics and biochemistry. Statistics and organic chemistry are also useful.

“ If you discover that the subject fascinates and excites you, then persevere through the rather mundane but essential early stages of a university career. To be a good microbiologist, you need to understand more than microbiology: genetics, chemistry, statistics, population biology, ecological theory, etc., all of which may be relevant to a future career. Once you have succeeded in acquiring the basics at BSc/BSc (Honours) level, a world of excitement awaits you in the research elements of your training – at MSc, PhD and even postdoctoral levels. ”

Professor Donald Cowan





**Job:** Professor and Dean of Engineering and the Built Environment

**Where:** University of Johannesburg

**Qualifications:** BSc (Mechanical Engineering), MSc (Mechanical Engineering), PhD (Computational Intelligence)

### Why did you choose this path?

In my matriculation year, I entered and won the National Science Olympiad and was sent to the United Kingdom to attend the London International Youth Science Fortnight. I used this opportunity to visit the University College of London and Oxford University where I gained an appreciation of the importance of engineering and science for the development of modern society.

Determined to make a difference in my own country, I made up my mind to follow a career in engineering. In 1991 I was awarded a scholarship by the Educational Opportunities Council to study at Case Western Reserve University in the United States of America. Upon returning to South Africa I furthered my studies at the University of Pretoria and obtained a Master's and PhD degrees.



Professor Tshildzi Marwala

“Determined to make a difference in my own country, I made up my mind to follow a career in engineering.”

### There are lots of things you can do with an Engineering degree

Tshildzi Marwala, for example, worked at a science council and in industry before moving into academia.

His career so far has included:

- Six years as a project engineer at the Council for Scientific and Industrial Research (CSIR);
- A stint in industry at South African Breweries developing artificial tasters and an electronic nose;
- Heading up the Control and Systems Group in the School of Engineering at the University of Witwatersrand.





**What you need to get there:**

**School subjects:**

Mathematics and Physical Science are needed (and Geography is useful).

**University qualifications:**

Enrol for a Meteorology degree, offered by the University of Pretoria. Other universities offer relevant degrees in Climatology or Atmospheric Science.

Alternatively, take Physics or Mathematics at undergraduate level and then register for honours in Meteorology. A minimum of an honours degree is needed and it is advantageous to have a postgraduate qualification.

**What is atmospheric modelling?**

Models are tools that can be used to study processes going on in the atmosphere.

They produce a lot of data to help make decisions in different sectors such as water and air quality management, agriculture and the insurance industry. Model data can also be studied to understand atmospheric processes, such as the formation of clouds and the development of cyclones.

Developing a model involves studying a process you want to model, writing equations that represent the process, and coding the equations so that a computer can solve them.

**Mary-Jane Bopape’s advice:**

“ The increased focus on climate means there are now many job opportunities and there is so much that we still have to understand about climate variability and change. In South Africa the climate science community is still very small and there is more work to be done than there are people able to do it – so it is a good career to pursue!

At a personal level, you must be happy to sit and work on your own in front of a computer. Also, you should enjoy working with numbers and graphs, and reading. Confidence is needed to share the findings of your research at conferences.



**Job:** Atmospheric modeller

**Where:** Mary-Jane Bopape is a Senior Researcher in the Natural Resources and the Environment Unit of the Council for Scientific and Industrial Research (CSIR) based in Pretoria.

**Qualification:** PhD

**A typical day:** A lot of our work involves using the computers at the Centre for High Performance Computing (CHPC) in Cape Town that we connect to remotely. After submitting a run on a computer, we have to check it continually as long simulations can run for a few weeks. Once completed, we analyse the output data and study certain atmospheric processes to understand how they will change with global warming. We also extract the data and write it in formats needed by people in other sectors that are doing impact studies.

**Why is my job important?** Atmospheric modellers can use models developed by other scientists or develop their own. Although currently South Africa uses models that were developed elsewhere, my PhD research is contributing to the development of a South African model. I hope to see it used to make operational weather forecasts, seasonal predictions and even decadal climate simulations – which is my speciality.

**Why did you choose this path?** During my last couple of years at school my favourite subjects were Mathematics, Physics and Geography, in which I especially liked Climatology. I liked understanding why it was raining and why it got cold in winter. During my Matric year I initially thought I would study Engineering of some sort, until my mother brought me a brochure from the South African Weather Bureau (now the South African Weather Service) describing how to become a meteorologist. I decided there and then that Meteorology was the career for me!

I enjoy working with equations and coding them up to simulate processes. There are often errors along the way and I enjoy the challenge of finding and solving them. The greatest reward comes just after a simulation is finished and you display the data, not knowing what to expect – as it may be completely new information. There is also a lot of travelling involved and so far I have been to Italy, China, Japan, Australia, Egypt and the United States on work-related trips.



**Job:** Environmental biotechnologist

**Where:** Sasol's Research and Development Department in Secunda.

**Qualifications:** BSc (Microbiology and Biochemistry), BSc Hons (Biotechnology) and MSc (Biotechnology).

**A typical day:** I specialise in waste water treatment. Sasol is an international chemical and fuel company that uses a lot of water for cooling. This results in a lot of different types of waste water (sewage).

My job is to evaluate new technologies and to find the best and cheapest ways of cleaning this waste water. Some of the water is cleaned using 'biological treatments' – meaning that micro-organisms are used. These 'bugs' use carbon in the waste water as an energy source. I help to find the micro-organisms that can be used in the recycling and to break down and remove toxins from waste.

### What you need to get there:

**School subjects:** Mathematics, Physics and Biology are important school subjects.

**Qualifications:** At university you have to enrol for a BTech or BSc with Biochemistry, Biotechnology, Microbiology, Chemical and/or Biological Sciences. You need a Master's or PhD for a research position.



### Patricia Molipane's advice

“ You need to be a team player and have good interpersonal skills, independent problem solving abilities, be assertive and self-motivated. ”



**What you need to get there:**

School subjects:  
Matric Maths and Science

University qualifications:  
A three-year BSc degree majoring in Chemistry and Physics, an Honours degree in Chemistry, and Master's and Doctoral degrees in Organic Chemistry.



**Job:** Organic chemist

**Where:** The Biomedical Research Programme at Mintek, South Africa's national mineral research organisation. The programme is a partnership between Mintek and Harmony Gold, aiming to find novel industrial applications for gold.

**Qualification:** PhD

**A typical day:** Gold is a metal with therapeutic value and Mintek's Biomedical Programme is currently doing research on the discovery of gold-based drugs for the treatment of HIV, cancer and malaria. Research has shown that the use of gold in efforts to discover new drugs can offer various advantages. The research team based at Mintek focuses primarily on gold-based drugs for HIV treatment. The programme was started in 2002 through various university collaborations. Dr Coates joined Mintek in 2003 and was one of two staff members in the programme. Today she heads a group of six researchers at Mintek and is overseeing a wider consortium of 32 researchers at local universities.

**Judy Coates**

“ If you enjoy science at school, consider studying it further at university. In the pre-graduate years you will study many generic subjects, but during your Master's studies you will start specialising and that is when science becomes really exciting.

Once you are in a job, build your professional reputation among your colleagues and people outside your organisation. Be very professional in your interactions with others. Network, collaborate on projects, and earn respect in your workplace. Go that extra mile to prove yourself.



**Why did you choose this path?** I had a very passionate Science teacher at school who ignited and fuelled my love for Science. When I was in matric and was torn between studying Accounting and doing Science, a family friend said I was the type of person that needed challenges, and that a career in Science would offer new challenges every day. She was correct.

At university I had a role model in my first-year Chemistry lecturer. In my second year I started assisting her in practical sessions. I worked closely with her through my years at university. During the course of my doctorate I was undecided whether I should stay in the academic field and lecture, which I enjoy very much, or should start a research career in industry. I am very blessed that I now have the best of both worlds: I still interact closely with the university and I am involved in research projects at Mintek.

Seeing the students I interact with grow into well-rounded scientists and reach their goals is awesome. Seeing that my colleagues in the Biomedical Programme are enjoying their careers – that just does it for me!



# Financing

## your SET studies

Now that you have an idea of which SET path you want to embark upon, and in which type of institution, let's look at how to finance your studies.

There are different sources of financing available to learners who wish to study in universities and FET colleges. Those who plan to study in SET careers have an advantage because careers in science, engineering and technology have been earmarked for funding by the government as well as the private sector.





The following sources of funds are available:

### Bursaries

Bursaries are awarded on the basis of academic merit and other criteria, including financial need. They are awarded by companies, private and religious organisations or government departments.

The tide has changed and bursaries are more readily available after many years of being hard to obtain. Most bursaries are, however, for those who study in scarce skills (including all the SET careers) as well as finance, mathematics and science teaching.

Bursaries often have conditions attached to them. For example, you may need to work for the company that provides the bursary for a specified period once you have completed your studies.

### Scholarships

A scholarship is financial assistance awarded for outstanding academic achievement. Usually no employment conditions are attached to a scholarship.

### Bank loans

Most banks offer student loans at special interest rates, which are lower than normal rates. A parent or someone with assets has to sign as surety (to guarantee repayment).

### Government loans – the National Student Financial Aid Scheme (NSFAS)

Even if you come from a disadvantaged background, and you are not eligible for a bursary or scholarship, you can still study further at a university or a state FET college. The National Student Financial Aid Scheme offers loans to prospective students whose family members cannot afford to pay for them to study.

### A NSFAS loan works as follows:

- The size of the loan depends on the number of courses for which the learner enrolls.
- It normally covers the registration fees as well as an allowance for books.
- It can include an amount for accommodation.
- The interest rate is much lower than rates at banks.
- 40% of the loan is converted to a bursary if a learner passes all their courses – they then only repay 60% of the original loan.
- Repayment only starts after completion of the diploma or degree, once the person has a job and is earning a salary.
- A learner should apply for a NSFAS loan at the institution where he/she wants to study. The procedure is as follows:
  - Choose a career and the diploma or degree you want to follow.
  - Apply for the course at the institution.
- If you are accepted, you can then apply for a NSFAS loan at the institution. The college will provide the application forms and oversee the application process

For more information, visit [www.nsfas.org.za](http://www.nsfas.org.za), email: [info@nsfas.org.za](mailto:info@nsfas.org.za); tel: 021 763 3232





## Where can I find information about financial aid?

Information about financial aid is available through the following:

**1. Tertiary institutions.** Most institutions have their own bursary schemes, so contact them directly for information. Most institutions also host Open Days at which they showcase their courses and offer information and options about financing your studies. Keep an eye on the local media for advertisements about these Open Days or visit the institution's website.

**2. Companies and professional associations.** Big companies, such as Eskom, Telkom, Spoornet, South African Airways and banks can also be contacted for information about bursaries. Career books often have addresses and contact numbers for these.

**3. Local or provincial government.**

**4. Parents' employers.**

**5. Religious organisations.**

**6. Newspapers.** Companies often use newspapers through which to advertise financial aid and bursaries. Companies also advertise jobs in the field in which you want to study. Write down the contact information and write a letter to the company enquiring about financial assistance.

**7. The Bursary Register.** This is a booklet which contains current information about all available bursaries, scholarships and loans. It applies to FET college applicants as well as university applicants. It is available for sale at bookstores but can be ordered from Riva Levin on 011 672 6559 or rlevin@mweb.co.za

**8. Libraries.**

**9. Employers at career exhibitions and career fairs.** These events are normally advertised in local newspapers.

**10. The Internet** has lots of current information about SET bursaries and scholarships. For example, the National Science and Technology Forum, the Department of Science and Technology and UNESCO South Africa have launched a new web portal to assist learners and students in accessing bursaries. This groundbreaking project aims to create a database of SET courses, careers, and bursaries to assist school leavers and students in planning their studies and future careers. [Visit the portal at www.sciencebursaries.org.za](http://www.sciencebursaries.org.za)



## PROFESSIONAL DEVELOPMENT PROGRAMME

The Professional Development Program is about creating opportunities for suitable candidates from previously disadvantaged backgrounds to develop and promote their existing skills, potential and talents to their ultimate benefit as well as that of the ARC, Agricultural sector and the Science and Technology sector for the economic growth of South Africa.

One of the major factors leading to this project is the scarcity of adequately qualified and skilled natural scientists in the labour market. The development of this capacity, within the category of young agricultural graduates from disadvantaged communities and groups, is seen as the most important objective to be achieved through this program.

### Conditions of Service

Successful applicants are appointed on a fixed term contract basis for the duration of their study program. The participants are mentored by ARC Senior Researchers and candidates are evaluated throughout the program.

### REQUIREMENTS (CANDIDATES)

This program is aimed at benefiting South African citizens. Applicants must have an interest in pursuing a career in agricultural research and /or science and technology.

Applicants should be in possession of the following degrees or studying towards the following fields:

**BSc:** BSc (Engineering); BVSc;

**MSc:** in Natural Science e.g. Botany, Biochemistry, Biology, Microbiology, Mathematics, Statistics, Physiology, Zoology

**PhD candidates must be studying** in Natural Science e.g. Botany, Biochemistry, Biology, Microbiology, Mathematics, Statistics, Physiology, Zoology

### Benefits for Candidates

Special projects, such as the Professional Development Program, can contribute substantially to the development of young people for future employment within the Science and Technology environment. Full cover of:

**Study Fees; Mentorship; Life Skills Training and a Stipend**

### Contact Persons & Details

Applications, together with a FULL CV and certified statement of most recent academic record, must be sent to: Manager: Training & Development, ARC, PO Box 8783, PRETORIA 0001- Attention Mrs LK Molohe Tel (012) 427 9859, Fax (012) 430 5814; E-mail: [Lorraine@arc.agric.za](mailto:Lorraine@arc.agric.za).





## How to apply for a bursary

The first step in applying for a bursary is to write your CV.

The name Curriculum Vitae (CV) refers to the history of your life and experience. Learners do not have much experience except for community or school activity involvement. Generally their CVs are straightforward and can be used for most job applications. It must, however, be stressed that companies expect tailor-made CVs. A CV should show that the applicant has researched the company, thought carefully about his/her skills and what contribution they can make to the company, and why he/she wants to work at that particular company.

### Tips for learners

When writing a CV, look at it from an employer's point of view. Would you stand out against the competition (the other candidates) and would the manager want to talk to you for a possible job? **Writing a CV is hard work.** It is not just about the way you put together your personal data, but rather the way that personal and professional information is arranged to attract the attention and interest of the prospective employer. It is the most important tool in job searching since it creates the first impression about you in an employer's mind.

**A CV has one role – to get you an interview.** You only need to introduce yourself, your skills, experience and qualifications to a prospective employer. Use the following basic guidelines and adapt them to show your skills in the best light.

### Guidelines for writing a good CV

- Keep it short (about two pages).
- Use simple language and short sentences.
- Be positive and enthusiastic.
- Do not attach too many pages and documents to it.
- Make it look good – and always type it.
- Check the spelling and grammar (get someone else to check it too).
- Use only blue or black ink for printing your CV. Never use red or any other colour to highlight anything. Write headings in bold letters.
- The covering letter should match the CV paper and letter type.
- Do not use type smaller than 11 pts because it is difficult to read. Use Arial or Times New Roman as the font. Do not use handwriting or any artistic fonts on the CV.
- If you apply for a specific job it is best to tailor-make your CV for that job. Do this by:
  - Finding out as much as possible about the company.
  - Analysing the advertisement and writing about the skills you have that suit these requirements.
  - Reworking the CV so that it catches the attention of the prospective employer.A common mistake is for people to draw up a general CV and only change the covering letter. Since each job is specific and has special requirements, a general CV cannot match all the jobs. You should, for best results, have a master CV on your computer or on a disc, which you can copy and then change when necessary.

## What should go into a two-page CV?

The main items you need to include are:

- **Personal details.** Give your full name and an address and phone number where the employer can contact you. Include your ID number to prove your citizenship. Do not give other personal and family details, such as dependants, marital status, etc.
- **Career or personal objective.** Say what you want to achieve in your working future. This helps the employer relate your skills to the job.
- **Education and training.** Include details of your schooling and other training. List the subjects studied.
- **Work experience.** If you have done any vacation work or volunteer work, give the job title, the employer's name, the date you started and finished and a brief description of the work you did.
- **Skills and abilities.** List any skills you have acquired through your volunteer or vacation work or any other involvement. An example is the leadership skills you might have acquired while being on the students' representative committee, or the communication skills you learnt as a team member in the local debating team.
- **Other interests.** Give brief details of your hobbies and interests. Include anything else you think is important, such as a driver's licence or your state of health.
- **References.** Include the names of at least two previous employers or people who know you well. These could be a teacher, clergy person or community leader. Ask their permission first and let them know that they might be contacted.





## Letter of application

Use the following example and write an application letter for a bursary to a company or institution.

[Your address]  
[Your phone number]  
[Date]

[Employer's name and title]  
[Employer's address]

Dear [Name of HR Manager]

**Bursary inquiry**

I have seen your invitation for applications for a bursary for [specific career or career field you intend studying] in the [name of newspaper or information book].

Or

I would like to inquire whether your company offers any form of financial assistance, such as bursaries or scholarships to prospective students.

I am currently in Grade 12 at [name of school] and plan to study further at [name of higher education institution] for a degree/diploma in [name of course, e.g. electrical engineering].

Attached is my CV for your perusal. I look forward to your response.

Sincerely

[Sign your name]

[Type your name]

## Funding your postgraduate studies

Once you have obtained your first degree, there are many funding opportunities available if you decide to continue with postgraduate studies. The NRF's Scholarships and Fellowships Programme, for instance, provides support to postgraduate students. The manual which sets out all the possibilities, rules and regulations is available on the NRF website: [www.nrf.ac.za](http://www.nrf.ac.za).

The award of these scholarships to students is based on potential and academic performance. The following selection criteria are taken into consideration:

- Academic merit;
- Promise of research ability;
- Significance and relevance of proposed research;
- Leadership qualities;
- Previous prizes and awards;
- The likelihood that the candidate will successfully complete an Honours, Master's or Doctoral degree or post-Doctoral research;
- Capacity of the institution to support the proposed research;
- Recommendation of supervisor and referees;
- Race and gender targets (previously disadvantaged individuals and specifically black females will be given priority); and
- The scientific merit of the application: i.e. how well the research problem is conceptualised and how well the approaches/methods and techniques are described.

Applications are assessed by panels of experts consisting of highly acclaimed academic members in the research community covering the various disciplines supported by the NRF.

### Dates and deadlines

For dates and deadlines, as well as information on how to apply, you should contact the financial aid/bursary/postgraduate office of the institution where you intend registering to study.





## NRF scholarships and fellowships

The scholarships and fellowships that are available may vary from year to year. For studies in 2012, for instance, the following were offered:

- Honours/Final Year BTech Scholarships
- Master's Scholarships
- Doctoral Scholarships
- Post-Doctoral Fellowships
- Professional Development Programme

**The Honours/Final Year BTech Scholarships** are available as NRF Free-standing, Innovation and Scarce Skills Scholarships. Students are supported for one year and the values of the scholarships vary between R20 000 and R35 000.

- Innovation Scholarships and NRF Free-standing Scholarships support students who intend studying in the social and human sciences (SSH), natural and applied sciences as well as engineering and technology (SET). In the case of the Innovation Scholarships, 80% of the awards will be made in SET and 20% in SSH. In the case of the NRF Free-standing Scholarships, 60% of the awards will be made in SET and 40% in SSH.
- Scarce Skills Scholarships are available for studies in Accounting, Actuarial Sciences, Agricultural Sciences, Auditing, Biotechnology, Chemistry, Computer Sciences, Demography, Engineering (all fields), Financial Management, Geology, Information Communication Technology, Mathematical Sciences, Physics, Transportation Studies, Tourism and Statistics.

**Master's Scholarships** are available as NRF Free-standing Scholarships, Innovation Scholarships and Scarce Skills Scholarships. The values of these scholarships vary between R40 000 and R70 000 per year and the deadline for application is usually at the end of August. The fields of study that are supported are much the same as for Honours and final-year BTech studies.

The same scholarships are available to **doctoral students**. They are supported for three years and the values of the scholarships vary between R60 000 and R100 000 per year. **Postdoctoral Fellowships** are available as NRF Free-standing, Innovation, and Scarce Skills Fellowships.

**The Professional Development Programme** supports prospective doctoral and postdoctoral candidates who intend to carry out research at research councils such as CSIR, MRC, etc., national research facilities such as IThemba Labs, SAEON etc. and research institutions such as museums etc. in fields identified by these institutions as critical focus areas.

## Nanotechnology-related bursaries and scholarships

Most universities are now offering postgraduate degrees by research project in nanotechnology. Many of these SA universities do research in partnership with industry (e.g. Sasol, Element 6, Rand Water, Eskom), research centres (e.g. CSIR, Mintek, NECSA) and other universities around the world. Details of research topics (Master's and PhD level) can be obtained by searching the name of the institution on the Internet. Several government agencies, research institutions and foundations, and private companies offer bursaries/scholarships and even internships for nanotechnology-based studies in South Africa.

**National Research Foundation** has various programmes ranging from undergraduate to postdoctoral studies in the form of scholarships and grants that support nanotechnology-based research. [www.nrf.ac.za](http://www.nrf.ac.za)

**The DST/NRF Centre of Excellence in Strong Materials** is a research network hosted by Wits University in partnership with other universities and organisations. [www.dst.gov.za/centre-of-excellence](http://www.dst.gov.za/centre-of-excellence)

**The CSIR** offers bursaries and studentships to students who are registered and based at universities or the CSIR itself. The DST/CSIR National Centre for Nanostructured Materials is dedicated to nanoscience and nanotechnology. [www.csir.co.za](http://www.csir.co.za)

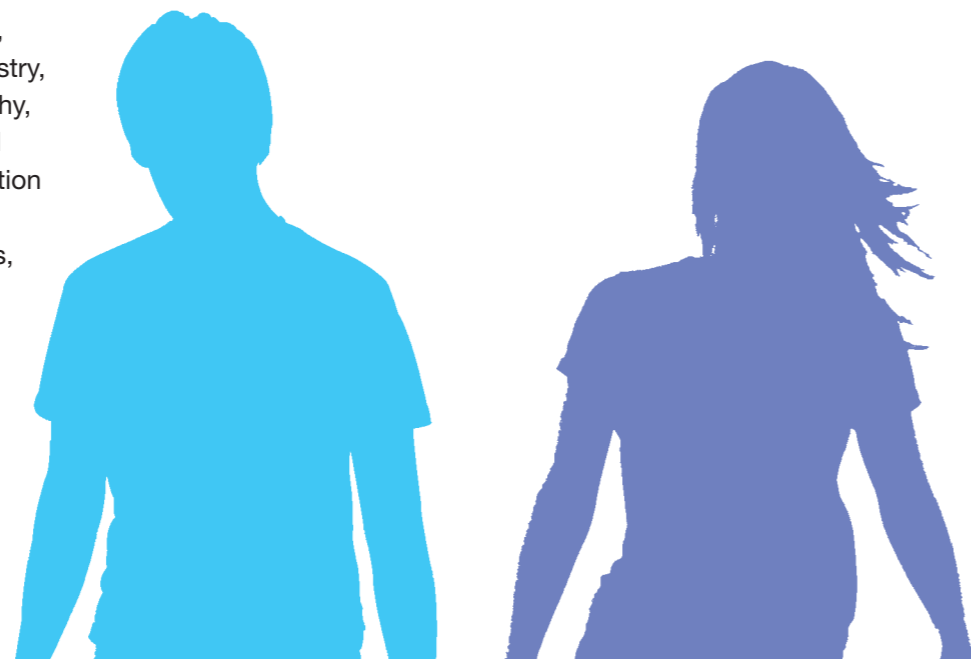
**Sasol** is a petrochemical company which funds projects at universities with an interest in catalysis. For example, a research partnership exists between Sasol and UCT which adds great value to research in nanotechnology. [www.sasolbursaries.com](http://www.sasolbursaries.com)

**Microscopy Society of Southern Africa** supports microscopy studies of which most involve nanoparticles. [www.microscopy.org.za](http://www.microscopy.org.za)

**India/Brazil/South Africa Programme** is a collaborative programme between the departments of science and technology of these countries. It supports education and human resource development in the area of nanotechnology. [www.ibsa-nano.igcar.gov.in](http://www.ibsa-nano.igcar.gov.in)

## DAAD/NRF Joint In-Country Scholarships

**The German Academic Exchange Service (DAAD) in partnership with the NRF** offers two-year Joint In-Country scholarships for postgraduate students in South Africa studying towards a Master's or Doctoral degree. Applicants may come from all fields of study that have a strong relevance to national development (Natural Sciences, Mathematics, ICT, Engineering, Agricultural Sciences, Applied Social Sciences). The humanities and fine arts are excluded from this programme unless the research has a social focus.





## Square Kilometre Array (SKA) bursaries, scholarships and fellowships

The South African Square Kilometre Array Project (SKA SA) is a project of the Department of Science and Technology, administered by the NRF. SKA SA is currently designing and constructing the MeerKAT Radio Telescope in the Karoo Region of the Northern Cape Province.

MeerKAT is a world-class radio telescope and is designed to do groundbreaking science. Via MeerKAT, South Africa is participating in the design and technology developments of the Square Kilometre Array Radio Telescope. In collaboration with South African industry and

universities, and collaborating with leading global institutions, the South African team has developed innovative technologies in areas such as antenna engineering and signal processing hardware and algorithms.

For more information on their Artisan and Internship Programmes, in-service training for National Diploma students, National Diploma and Bachelor of Technology bursaries, undergraduate and honours bursaries, postgraduate bursaries and Postdoctoral Fellowship programme, visit the website <http://www.ska.ac.za/students/bursaries.php> or contact Rose Robertson at [Rose@nrf.ac.za](mailto:Rose@nrf.ac.za).

## Institutional contact details

### Universities

University of Cape Town	Tel: 021 650 2105/6	Fax: 021 650 5100	<a href="http://www.uct.ac.za">www.uct.ac.za</a>
University of Fort Hare	Tel: 040 653 2312	Fax: 040 653 1338	<a href="http://www.ufh.ac.za">www.ufh.ac.za</a>
University of the Free State	Tel: 051 401 2114	Fax: 051 401 3669	<a href="http://www.ufs.ac.za">www.ufs.ac.za</a>
University of Johannesburg	Tel: 011 489 3000	Fax: 011 489 2260	<a href="http://www.uj.ac.za">www.uj.ac.za</a>
University of KwaZulu-Natal	Tel: 031 260 2227	Fax: 031 262 2192	<a href="http://www.ukzn.ac.za">www.ukzn.ac.za</a>
University of Limpopo	Tel: 015 268 2140	Fax: 015 267 0142	<a href="http://www.ul.ac.za">www.ul.ac.za</a>
Nelson Mandela Metropolitan University	Tel: 041 504 2075	Fax: 041 504 9211	<a href="http://www.nmmu.ac.za">www.nmmu.ac.za</a>
North West University	Tel: 018 299 2601	Fax: 018 299 2603	<a href="http://www.nwu.ac.za">www.nwu.ac.za</a>
University of Pretoria	Tel: 012 420 4111	Fax: 012 420 4555	<a href="http://www.up.ac.za">www.up.ac.za</a>
Rhodes University	Tel: 046 603 8148	Fax: 046 622 8444	<a href="http://www.ru.ac.za">www.ru.ac.za</a>
University of South Africa	Tel: 012 429 3111	Fax: 012 429 2565	<a href="http://www.unisa.ac.za">www.unisa.ac.za</a>
University of Stellenbosch	Tel: 021 808 9111	Fax: 021 808 3822	<a href="http://www.sun.ac.za">www.sun.ac.za</a>
Walter Sisulu University for Technology	Tel: 047 502 2200	Fax: 047 502 2970	<a href="http://www.wsu.ac.za">www.wsu.ac.za</a>
University of Venda	Tel: 015 962 8000	Fax: 015 962 4742	<a href="http://www.univen.ac.za">www.univen.ac.za</a>
University of the Western Cape	Tel: 021 959 2911	Fax: 021 959 2973	<a href="http://www.uwc.ac.za">www.uwc.ac.za</a>
University of the Witwatersrand	Tel: 011 717 1102/2050	Fax: 011 339 8215	<a href="http://www.wits.ac.za">www.wits.ac.za</a>
University of Zululand	Tel: 035 902 6624	Fax: 035 902 6601	<a href="http://www.uzulu.ac.za">www.uzulu.ac.za</a>

### Universities of Technology

(Source: Department of Higher Education and Training (March 2013))

Cape Peninsula University of Technology	Tel: 021 460 3911	Fax: 021 460 3700	<a href="http://www.cput.ac.za">www.cput.ac.za</a>
Central University of Technology	Tel: 051 507 3911	Fax: 051 507 3310	<a href="http://www.cut.ac.za">www.cut.ac.za</a>
Durban University of Technology	Tel: 031 373 2411	Fax: 031 373 2011	<a href="http://www.dut.ac.za">www.dut.ac.za</a>
Mangosuthu Technikon	Tel: 031 907 7111	Fax: 031 906 5470	<a href="http://www.mantec.ac.za">www.mantec.ac.za</a>
Tshwane University of Technology	Tel: 012 382 5911	Fax: 012 382 5422	<a href="http://www.tut.ac.za">www.tut.ac.za</a>
Vaal University of Technology	Tel: 016 950 9214/5	Fax: 016 950 9800	<a href="http://www.vut.ac.za">www.vut.ac.za</a>



Public FET Colleges

[http://www.fetcolleges.co.za/Site\\_Public\\_FET.aspx](http://www.fetcolleges.co.za/Site_Public_FET.aspx)

College Name	Postal Address	Physical Address	Telephone & Fax
<b>Province: Eastern Cape</b>			
Buffalo City FET College	Private Bag 9016 East London 5200	Cnr Lukin Road & King Street Selborne East London 5201	T: 043 704 9218 F: 043 743 4254
East Cape Midlands FET College	Private Bag X35 Uitenhage 6230	Cnr Cuyler & Durban Street Uitenhage 6229	T: 041 995 2000 F: 041 995 2008
Ikhala FET College	Private Bag X7110 Queenstown 5320	Robinson c/n Zeiler Street Queenstown 5320	T: 047 873 8843 F: 086 519 2489/ 086 613 0118/ 047 873 8844
Ingwe FET College	P O Box 92491 Mt Frere 5090	Cancele Road Mt Frere Eastern Cape 5090	T: 039 255 1204/ 039 255 1415/ 039 255 1417 F: 039 255 0347
King Hintsa FET College	Private Bag X3018 Butterworth 4960	Factory No 1234 Acrytex Building Centane Road Buttterworth	T: 047 401 6400 F: 047 492 2398
King Sabata Dalindyebo FET College	Private Bag X5011 Umtata 5099	Engcobo Road c/n Cicira	T: 047 505 1001/2 F: 047 536 0932
Lovedale FET College	P O Box 2156 King Williams Town 5600	Amatola Row King Williams Town 5600	T: 043 642 1331 F: 043 642 1388
Port Elizabeth FET College	Private Bag X6040 Port Elizabeth 6000	139 Russell Road Central Port Elizabeth	T: 041 585 7771 F: 041 582 2281
<b>Province: Free State</b>			
Flavius Mareka	Private Bag X2009 Sasolburg 1947	Cnr Hertzog Road and Fraser Street Sasolburg 1947	T: 016 976 0815/ 016 976 0829 F: 016 976 3485
Goldfields FET College	Private Bag X95 Welkom 9460	36 Buren Street Flamingo Park Welkom 9460	T: 057 910 6000 F: 057 392 1082
Maluti FET College	Private Bag X870 Witsieshoek 9870	Mampoi Street Phuthaditjhaba Qwaqwa 9866	T: 058 713 6100 F: 058 713 6492

Public FET Colleges

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College Name	Postal Address	Physical Address	Telephone & Fax
Motheo FET College	Private Bag X20509 Bloemfontein 9300	73 Douglas Street Bloemfontein 9301	T: 051 406 9330/1 F: 051 406 0340
<b>Province: Gauteng</b>			
Central JHB	Private Bag X70500 Houghton 2041	5 Ubla Road Parktown 2041	T: 011 484 1388/ 011 351 6000 F: 011 642 7358
Ekurhuleni East FET College	Private Bag X52 Springs 1560	Sam Ngema Road Kwa-Thema Springs 1560	T: 011 736 4400/ 011 730 6600 F: 011 736 1489/ 011 736 9909
Ekurhuleni West College	Private Bag X1030 Germiston 1400	Driehoek and Sol Road Germiston 1400	T: 086 139 2111 F: 011 323 1601
Sedibeng FET College	Private Bag X020 Vereeniging 1930	37 Voortrekker Street Vereeniging 1930	T: 016 422 6645 F: 016 422 6930/ 016 422 6646
South West FET College	Private Bag X33 Tshiawelo 1718	Koma c/n Molele Road Molapo Section Soweto	T: 011 527 8300 F: 011 984 1262
Tshwane North FET College	P O Box 26193 Arcadia 0007	Cnr Potgieter & Pretorius Street Pretoria 0001	T: 012 401 1941/ 012 401 1600 F: 012 323 6863
Tshwane South FET College	Private Bag X1018 Lyttelton 0140	85 Schoeman Street Pretoria 0001	T: 012 401 5021 F: 012 401 5011 086 660 9313
Western College FET	Private Bag X17 Randfontein 1760	42 Johnstone Street Hectorton Randfontein 1760	T: 011 692 4004 F: 011 692 3404
<b>Province: KwaZulu-Natal</b>			
Coastal FET College (Mobeni)	P O Box 1795 Amanzimtoti 4125	No 50051 Old Main Road Kwa Makhutha 4125	T: 031 905 7200 F: 031 905 1399
Elangeni FET College	Private Bag X9032 Pinetown 3600	15 Portsmouth Road Pinetown 3610	T: 031 716 6700 F: 031 716 6777
Esayidi FET College	Private Bag X713 Port Shepstone 4240	3 Shooters Hill Lot 462 Nelson Mandela Drive Port Shepstone 4249	T: 039 318 1433 F: 039 684 0280



Public FET Colleges

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College Name	Postal Address	Physical Address	Telephone & Fax
Majuba FET College	Private Bag X6602 Newcastle 2940	83 Allen Street Newcastle 2940	T: 034 326 4888 F: 034 326 4889/ 034 326 4855
Mnambithi FET College	Private Bag X9903 Ladysmith 3370	77 Murchison Street Ladysmith 3370	T: 036 637 4790 F: 036 631 4146
Mthashana FET College	P O Box 9424 Vryheid 3100	266 South Street Vryheid 3100	T: 034 981 5337 F: 034 980 1012
Thekwini FET College	Private Bag X06 Dormerton 4015	262 Daintree Avenue Asherville 4091	T: 031 250 8400/ 031 250 8248/ 031 250 8256 F: 031 250 8414
Umfolozu FET College	Private Bag X5023 Richards Bay 3900	Cnr Via Richardia & Naboomnek Richards Bay 3900	T: 035 902 9503 F: 035 789 2585
Umgungundlovu FET College	Private Bag X9060 Pietermaritzburg 3200	44 Burger Street Pietermaritzburg 3200	T: 033 341 2101 F: 033 345 9893/ 033 345 99827
<b>Province: Limpopo</b>			
Capricorn FET College	Private Bag X9674 Polokwane 0700	16 Market Street Polokwane 0700	T: 015 297 8367/ 015 297 8389 F: 015 297 5448/ 015 287 0439
Lephalale FET College	Private Bag X210 Lephalale 0555	Cnr Nelson Mandela & Ngwako Ramatlhodi Street Onverwacht 0557	T: 014 763 2252/ 014 763 1014 F: 014 763 2253
Letaba FET College	Private Bag X4017 Tzaneen 0850	No 1 Claude Wheatley Street Tzaneen 0850	T: 015 307 5440 015 307 2215 F: 015 307 2218
Mopani South East FET College	Private Bag X1024 Phalaborwa 1390	Cnr Combretum & Haarlem Streets Phalaborwa 1390	T: 015 781 5721/5 F: 015 781 5346
Sekhukhune FET College	Private Bag X8660 Groblersdal 0470	Stand No 676 Motetema 0473	T: 013 269 0278 F: 013 269 0450 086 620 9839

Public FET Colleges

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College Name	Postal Address	Physical Address	Telephone & Fax
Vhembe FET College	Private Bag X2136 Sibasa 0970	203 Sibasa Unit A 0970	T: 015 963 3156 015 963 3100 F: 086 546 3217
Waterberg FET College	Postnet Suit #59 Private Bag X2449 Mokopane 0600	36 Hooge Street Mokopane 0600	T: 015 491 8581/ 015 491 8602 F: 015 491 8579
<b>Province: Mpumalanga</b>			
Ehlanzeni FET College	Private Bag X11297 Nelspruit 1200	29 Bell Street Ehlanzeni FET College Central Office Nelspruit 1200	T: 013 752 7105 F: 013 752 4902/ 013 752 4908/ 013 752 8214
Gert Sibande FET College	P O Box 3475 Standerton 2430	18A Beyers Naude Drive Standerton 2429	T: 017 712 9040/ 017 712 1458/9 F: 017 712 9058/9 086 509 4156
Nkangala FET College	P O Box 2282 Witbank 1035	Cnr Haig & Northey Street Witbank 1035	T: 013 690 1430/ 013 690 3824 F: 013 690 1450
<b>Province: Northern Cape</b>			
Northern Cape Rural FET College	P O Box 1834 Upington 8800	Steve Naude Street Upington	T: 054 331 3836 F: 054 331 3966 086 572 5793
Northern Cape Urban FET College	Private Bag X5031 Kimberley 8300	Central Office 37 Long Street Kimberley 8301	T: 053 839 2000/ 053 839 2061 F: 053 839 2068
<b>Province: North West</b>			
Orbit FET College	Private Bag X82096 Rustenburg 0300	Cnr Bosch and Fatima Bhayat Street Rustenburg 0300	T: 014 592 8461/2 014 592 8814 F: 014 592 7013
Taletso FET College	Private Bag X128 Mmabatho 2735	Kgora Building Dr Albert Luthuli Drive Next to SABC Mmabatho 2735	T: 018 384 2346 018 384 2347/9 F: 018 384 7511
Vuselela FET College	P O Box 10107 Klerksdorp 2570	133 OR Tambo Street Klerksdorp 2571	T: 018 406 7800 F: 018 406 7810



## section 3 – getting there

### Public FET Colleges

[http://www.fetcolleges.co.za/Site\\_Public\\_FET.aspx](http://www.fetcolleges.co.za/Site_Public_FET.aspx)

College Name	Postal Address	Physical Address	Telephone & Fax
<b>Province: Western Cape</b>			
Boland FET College	Private Bag X5068 Stellenbosch 7599	85 Bird Street Stellenbosch 7600	T: 021 886 7111/2 F: 021 886 8182
College of Cape Town FET College	P O Box 1054 Cape Town 8000	Kent Street Salt River Cape Town 7925	T: 021 404 6700 F: 021 404 6701
False Bay FET College	Private Bag X25 Tokai 7966	Cnr Main & Atlantic Roads Muizenberg 7945	T: 021 003 0600 F: 086 603 0669
Northlink FET College	Private Bag X1 Panorama 7506	80 Voortrekker Road Bellville 7530	T: 021 970 9000 F: 021 970 9064
South Cape FET College	P O Box 10400 George 6530	125 Mitchell Street George 6530	T: 044 884 0359 F: 044 884 0361
West Coast FET College	P O Box 935 Malmesbury 7299	2 <sup>nd</sup> Floor, Clicks Building 48 Voortrekker Road Malmesbury 7300	T: 022 482 1143 F: 022 487 3983

There is also a number of private FET colleges in South Africa. If you decide to study at a private FET college, ensure that it is accredited with Umalusi, a SETA, or the Council for Higher Education. Public FET colleges do not require accreditation, as they are part of the government's network of learning institutions.

Accreditation for FET colleges means that these colleges provide learning of a specific standard that falls within the policy guidelines of Umalusi and the Department of Higher Education and Training. Accreditation is vitally important for any FET college, as it ensures that the qualifications offered by these institutes of learning comply with national guidelines, ensuring that they are useful in the workplace.

Do the following to ensure that the course you want to enrol for, and the college you want to attend, is accredited:

- Request written proof from the college that the qualification you intend to enrol for is registered on the NQF. The NQF ID number should be in

evidence. Otherwise you can check whether it is registered by going to the website for the South African Qualifications Authority.

The site is <http://www.saqqa.org.za>.

- Ask for evidence (this should be a certificate) that the provider is registered with the Department of Basic Education or the Department of Higher Education and Training to offer specific national qualifications. Also request evidence that the college is registered with the Department of Higher Education and Training. The college should present you with a registration number.

- Request proof from the college that it has approval or accreditation from the relevant SETA, Umalusi or the Council for Higher Education to offer the qualification.

If you follow these simple guidelines, you will ensure that you study at a registered college that has been accredited to offer the national qualifications up to NQF 4.

Source: [www.fetcolleges.co.za](http://www.fetcolleges.co.za)