

CHEMICAL ENGINEERING

The Department offers the following postgraduate programmes in coursework, in addition to MSc and PhD programmes:

Bioprocess Engineering
Catalysis and Catalytic Processing
Minerals Beneficiation

Research Entities:

Centre for Bioprocess Engineering Research
Catalysis Institute
Centre for Minerals Research
Crystallisation and Precipitation Research Unit
DST-NRF Centre of Excellence in Catalysis
Minerals to Metals
National Hydrogen Catalysis Competence Centre

The Department of Chemical Engineering is situated in the Chemical Engineering Building, which is on Upper Campus. Access to the Building is from South Lane, off Mandela Circle.

Website: www.chemeng.uct.ac.za

Staff

Professor and Head of Department

A Mainza, BSc(Eng)Chem *UNZA* PhD *Cape Town*

Professors

M Claeys, Dipl Ing(Chem Eng) Dr Ing *Karlsruhe*
DA Deglon, BSc(Eng) *Witwatersrand* MBA PhD *Cape Town* MSAIMM FSAAE
JCQ Fletcher, BSc(Eng)Chem PhD *Cape Town* MACS FSAAE
STL Harrison, BSc(Hons) *Cape Town* PhD *Cantab* MSAIChE SASM FSAIMM FSAAE ASSAF
FWISA
PJ Kooyman, Drs Chemie (MSc) *Leiden* PhD ChemE *Delft University of Technology* MSAIChE
AE Lewis, PrEng BSc(Eng)Chem MSc PhD *Cape Town* FSAIChE FSAIMM MASSAF FSAAE
FICHEM
KP Möller, BSc(Eng)Chem PhD *Cape Town*
J Petersen, BSc(Eng)Chem *Witwatersrand* PhD *Cape Town* MSAIMM
E van Steen, MSc(Eng) *Eindhoven* Dr.-Ing. *Karlsruhe* FSAIChE FSAAE AFICHEM
HB von Blottnitz, PrEng BSc(Eng)Chem *Cape Town* BSc(Hons) *UNISA* MSc *Cape Town* Dr Ing
RWTHAachen MSAIChE

Associate Professors

M Becker, BSc(Hons) Geology MSc *Cape Town* PhD *Pretoria*
JL Broadhurst, BSc(Hons) MSc *Port Elizabeth* PhD *Cape Town*
KC Corin, BSc(Hons) PhD *Cape Town*
NF Fischer, Dipl.-Ing.(Chem Eng) *Karlsruhe* PhD *Cape Town*
A Isafiade, BSc(Hons) *Ilorin* MSc *Ife* PhD *Cape Town* AMICHEM (Director of Postgraduate Studies)
PBJ Levecque, MSc(Eng) PhD *Leuven*

Emeritus Professors

J-P Franzidis, BSc(Eng) MSc Cape Town PhD *Open* MSAiChE MSAiMM
 CT O'Connor, PrEng BSc *UNISA* STD *Natal* BSc(Hons) PhD *Cape Town* DEng *Stell* FSAiMM
 FSAiChE FSAAE FRSSAf

Honorary Professors

JM Case, BSc(Hons) *Stellenbosch* HDE MSc *Cape Town* Med *Leeds* PhD *Monash* MASSAf
 I Govender, BSc *UDW* BSc(Hons)Physics PhD *Cape Town* HDE *UNISA*
 GJ Hutchings BSc(Chem) PhD *UCL* DSC (Heterogeneous Catalysis) *London* FICHEM FRS CBE
 MJ Nicol, BSc(Hons) PhD *Witwatersrand* FSAiMM, FAUSiMM
 JW Niemantsverdriet, BSc (Phys+Math) MSc *Amsterdam* PhD *Delft* (TechSciences)
 JG Petrie, CEng BSc(Eng)Chem *Cape Town* MSc *Houston* PhD *Cape Town* FICHEM

Honorary Associate Professor

B Cohen, BSc(Eng)Chem PhD *Cape Town*

Adjunct Professors

B J Chicksen, MBChB *Harare* FCP (SA) *Durban* MBA *Johannesburg*
 P Dempsey, NHD Metallurgy *Wits Technikon* BSc *UNISA* MDP *UNISA*
 CM Digby, BA Hons(Econ) *Trinity College Dublin* MA(Econ) *British Columbia*
 MSc(Enviroment) *London School of Economics and Political Science*
 AS Lambert, BSc(Hons) Extractive Metallurgy *Glasgow* FSAiMM
 JW Mann, BSc(Eng) Extractive Metallurgy *Witwatersrand* MBL *UNISA*
 R Schouwstra, BSc(Hons) *NWU* MSc *Johannesburg* DSc *NWU*
 MH Solomon, BSc(Eng)Mining, *Witwatersrand*, FSAiMM, FIQ, Mine Manager's Certificate of
 Competency (Metalliferous), MDP(Mining) *South Africa*
 WA van Dyk, BEng (Chemical, Extractive Metallurgy) PhD *Stellenbosch*
 DW Wright, BSc(Eng)Chem *Natal* MSAiChE FSAAE

Adjunct Associate Professor

PJ Notten, BSc(Eng)Chem PhD *Cape Town*

Senior Lecturers

L Bbosa, BSc(Eng)Elec-Mech MSc PhD *Cape Town* MSAiMM
 MA Fagan-Endres, BSc(Eng)Chem *Cape Town* PhD *Cantab*
 HR Heydenrych, BSc(Eng)Chem MSc *Cape Town*
 TP Mokone BSc Hons(Chem) *UFS* MSc *UFS* PhD(Chem Eng) *Cape Town*
 S Tai, BSc(Hons)*UMIST* MSc PhD *Delft* (Director of Undergraduate Studies)

Lecturer

T Rampai, BSc(Hons) MSc *Cape Town*

Contract Lecturers

E Govender-Opitz, BSc(Eng)Chem PhD *Cape Town*
 MS Manono, BSc(Eng)Chem MSc *Cape Town* PGDBM Regenesys, AMiChE, MSAiChE,
 MSAiMM
 MN Naidoo, BSc(Eng)Chem Eng *UKZN*
 T van Heerden, BSc(Eng)Chem MSc *Cape Town*

Honorary Research Associates

MJ Griffiths, BSc(Med)(Hons) MSc PhD *Cape Town*
 M Johnstone Robertson, BSc(Eng)Chem PhD *Cape Town*
 MA Petersen, BSc MSc *Cape Town* PhD *Cantab*
 RP van Hille, BSc MSc PhD *Rhodes*

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Chief Research Officer

MC Harris, BSc(Eng)Chem MSc *Cape Town*

Senior Research Officers

K Carden, BSc(Chem) MSc PhD *Cape Town FWISA*

BJ McFadzean, BSc(Hons) MSc *Port Elizabeth PhD NMMU*

APP van der Westhuizen, BEng *Stellenbosch MSc Cape Town*

JG Wiese NDip *CPUT MSc Cape Town*

Junior Research Fellow

J Waters, BTech(Chem Eng) *Cape Technikon MSc Cape Town*

Research Officers

PA Bepswa, BSc(Eng)Metallurgical *Zimbabwe PhD Cape Town*

RJ Huddy, BSc(Hons) PhD *Cape Town*

A Kotsiopoulos, BScChem MSc PhD *Cape Town*

N Hussain, BSc(Eng)Chem MSc *Cape Town*

NTJ Luchters, BTech *Leiden MSc Cape Town*

R Mohamed, BSc BScHons(Chemistry) MSc *NMMU PhD(Chem Eng) Cape Town*

Principal Technical Officer

HJ Macke, Dip Mechanical Engineering Technician, *Germany*

Chief Technical Officers

MA Jakoet, BSc(Eng) Mechatronics *Cape Town*

P Johnston, BSc *Cape Town*

Senior Technical Officers

RB Cupido, NDip(Analytical Chemistry) BTech(Chemistry) MTech(Chem) *CPUT*

G Kaufmann, PGDip *Cape Town Mtech(Chem) BTech(Chem) CPUT MSRM EMT-B Cape Town*

WP Koorts BTech(Chem Eng) MTech *CPUT*

CA Le Roux, NDip *CPUT BTech(Chem) UNISA*

IE Ngoma, BTech(Biotech) *TUT MTech CPUT*

Technical Officers

DJ Bramble

M Smart, BScHons MSc *Stellenbosch PhD Cape Town*

Chief Scientific Officer

J Chivavava, B(Eng) *NUST MSc(Eng) Cape Town*

Senior Scientific Officers

T Chivengwa, BSc(Eng) MSc *Cape Town*

AS Geldenhuys, BEng (Chem) *Stellenbosch*

T Khoza, BSc(Eng) Chem MSc(Eng) Chem *Cape Town*

Z Le Riche, ND(Analytical Chemistry) *CPUT*

M Lisso, BSc(Eng) Chem MSc *Cape Town*

MC Richter, BSc(Hons) Physics MSc PhD *Cape Town*

GA Yorath, BSc(Hons) Mineral Processing Technology *Cornwall*

Scientific Officer

RE Van Schalkwyk, BTech(Chem Eng) *CPUT*

Department Laboratory ManagerA Mentoor, BSc(Hons) MSc *Stellenbosch***Analytical Laboratory Manager**S Govender, BSc(AppChem) Hons(Chem) MSc *UKZN***Department Manager**

SI Pillay

Building Supervisor

E Matthews

Administrative Staff

B Cloete (Undergraduate Administrator)

B Davids (Postgraduate Administrator)

N Davids (Finance Assistant)

S Jeppie (Purchaser)

N Dili (Receptionist)

K Mfundisi (Administrative Assistant)

The Department offers both undergraduate and postgraduate programmes in Chemical Engineering. The undergraduate programme draws top school leavers from South Africa and further afield, with an annual intake of approximately 140 students. Graduates from this programme are highly sought-after in a wide variety of industries. The Department has dynamic research programmes and students who have obtained satisfactory results in their undergraduate courses are encouraged to return for postgraduate study. The Department's research activities are at present centered on:

- Biological leaching of mineral ores, with work concentrated on the fundamental processes involved
- Bioprocess engineering focused on biotransformation, process design, process kinetics, novel bioprocesses and the recovery of biological product;
- Catalysis research aimed at synthesis, characterisation and modelling of heterogeneous catalysts and their application in a variety of reactions and reactor types
- Crystallization and precipitation research focusing on metal recovery in mineral processing and metal removal for environmental protection and crystallization for water treatment
- Educational research aimed at improving the quality of undergraduate teaching and learning;
- Environmental process engineering, both at a conceptual and a practical level
- Hydrogen and fuel cell technologies focusing on fuel processing catalysis and devices, electrodes development and fuel cell and stack development
- Hydrometallurgy for metal extraction
- Minerals processing research focused on milling, classification and flotation of ores;
- Process modelling and optimization
- Process synthesis featuring the application of pinch technology to heat and mass transfer systems as well as the control of process systems
- Value recovery from waste, contributing to industrial ecology and the circular economy
- Water remediation, treatment, recovery and footprinting

Postgraduate Programmes

Master's Programmes

MSc in Engineering specialising in Bioprocess Engineering [EM024CHE01]

Professor and Convener:

STL Harrison, BSc(Hons) *Cape Town* PhD *Cantab* MSAIChe SASM FSAIMM FSAAE ASSAF
FWISA

Core Courses

Code	Course	NQF Credits	HEQSF Level
CHE5082Z	Dissertation Preparation (in 1st year)	0	9
CHE5002W	Dissertation Chemical Engineering	120	9
CHE5051Z	Microbial Physiology & Dynamics	8	9
CHE5070Z	Advanced Bioprocess Engineering	16	9
CHE5049Z	Chemical Engineering Topics for Scientists	16	9
CHE5054Z	Biotechnology Laboratory	8	9
CHE5055Z	Research Communication & Methodology	16	9
END5050X	Master's Journal Paper	0	9
	Minimum total credits	180	

Notes

CHE5051Z is a core course for engineering graduates.

CHE5049Z is a core course for life science graduates, but may be replaced by an equivalent course. Physical Science graduates will complete CHE5051Z and/or CHE5049Z or equivalent courses, dependent on their previous studies.

Elective or optional courses: 4 – 12 credits

MSc in Engineering specialising in Catalysis and Catalytic Processing [EM024CHE01]

Associate Professor and Convener:

N Fischer Diplom Ingenieur *Karlsruhe* PhD *Cape Town*

Core Courses for Chemical Engineering Graduates (students who have completed CHE4067F)

Code	Course	NQF Credits	HEQSF Level
CHE5002W	Dissertation Chemical Engineering	120	9
CHE5088Z	Introduction to Heterogeneous Catalysis Research	8	9
CHE5089Z	Characterisation Techniques for Catalysis Research	12	9
CHE5055Z	Research Communication & Methodology	16	9
CHE5082Z	Dissertation Preparation	0	9
END5050X	Master's journal paper	0	9
	Optional courses	24	9
	Minimum total credits	180	

Core Courses for Science Graduates (students who have not completed CHE4067F)

Code	Course	NQF Credits	HEQSF Level
CHE5002W	Dissertation Chemical Engineering	120	9
CHE4067F	Heterogeneous Catalysis	16	9
CHE5088Z	Introduction to Heterogeneous Catalysis Research	8	9

Code	Course	NQF Credits	HEQSF Level
CHE5089Z	Characterisation Techniques for Catalysis Research.....	12	9
CHE5055Z	Research Communication & Methodology	16	9
CHE5082Z	Dissertation Preparation	0	9
END5050X	Master's journal paper.....	0	9
	Optional courses	8	9
	Minimum total credits	180	

Master of Philosophy specialising in Sustainable Mineral Resource Development [EM026CHE05]

Professors and Co-conveners:

JL Broadhurst, BSc(Hons) MSc *Port Elizabeth* PhD *Cape Town*

Mining in Africa, as in the rest of the world, has changed from simply balancing production targets with cost control to a complex set of interrelationships including safety, health, the environment, sustainable development and proactive stakeholder management. This programme is aimed at providing an interdisciplinary postgraduate qualification that highlights the critical factors of sustainable development in the context of mining and minerals processing in Africa; including an understanding of, and a sensitivity and progressive approach to, managing and interacting with communities, environmental challenges, safety cultures, health-related issues and regulatory frameworks.

This trans-disciplinary Master of Philosophy (MPhil) Degree is offered through the Minerals to Metals Research Initiative within the Department of Chemical Engineering at UCT.

Students will complete the research component of the degree at UCT under supervision, and complete course work at UCT (including the UCT Graduate School of Business), the University of Stellenbosch and the University of Zambia. Credit and exemption will be granted for courses taken at other institutions, as shown below.

A candidate for the Master's specialising in Sustainable Mineral Resource Development shall complete coursework to the minimum of 60 credits, which includes all core courses listed below, and a 120 credit dissertation.

Code	Course	NQF Credits	HEQSF Level
CHE5002Z	Master's Dissertation: Chemical Engineering	120	9
CHE5087Z	Research Methodology	16	9
CHE5082Z	Dissertation Preparation	0	9
END5050X	Master's Journal Paper.....	0	9
CHE4054Z*	Environmental Stewardship in Mining & Minerals Beneficiation	12	8
CHE4055X	Practical Training in Sustainable Development.....	0	8
CHE4056Z*	Special Topics in Sustainable Development.....	16	8
GSB4264Z	Strategic Engagement Practice	16	8
	Total credits per year	180	

** indicates core courses offered elsewhere for which credit and exemption will be granted.*

University of Zambia (School of Mines)

'Environmental Stewardship in Mining & Minerals Beneficiation' (credit and exemption CHE4054Z)

University of Stellenbosch (Sustainability Institute)

'Advanced Introduction to Sustainable Development' (credit and exemption CHE4056Z)

Optional Courses for all Postgraduate Programmes

[EM_CHE_OPTIONAL COURSES]

In addition to the courses listed below, the core courses of the three programmes above may be used as optional courses in the other programmes.

Code	Course	NQF Credits	HEQSF Level
CHE5022Z	Introduction to Catalysis.....	16	9
CHE5030Z	Advanced Engineering Statistics I.....	8	9
CHE5040Z	Fuels & Chemicals from Oil.....	12	9
CHE5041Z	Instrumental Analysis Part A - General Measurement.....	4	9
CHE5042Z	Instrumental Analysis Part B - Chromatography.....	4	9
CHE5043Z	Instrumental Analysis Part C - Spectroscopy.....	4	9
CHE5045Z	Fuels & Chemicals from Coal & Syngas.....	12	9
CHE5047Z	Molecular Modelling.....	8	9
CHE5048Z	Crystallization and Precipitation.....	12	9
CHE5051Z	Microbial Physiology and Dynamics.....	8	9
CHE5052Z	Molecular Biology and Biocatalysis.....	8	9
CHE5054Z	Biotechnology Laboratory.....	8	9
CHE5064Z	Sustainability in Chemical Engineering.....	8	9
CHE5069Z	Advanced Thermodynamics and Separation Processes.....	8	9
CHE5070Z	Advanced Bioprocess Engineering.....	16	9
CHE5072Z	Fundamentals of Process Modelling.....	4	9
CHE5078Z	Advanced Numerical Methods for Engineers.....	16	9
CHE5079Z	Integrated Analysis of Mineral Beneficiation Systems.....	16	9
CHE5083Z	Translating Technology from the Laboratory to the Marketplace..	8	9
CHE5085Z	Hydrogen Technology.....	8	9
CHE5086Z	Electrochemical Characterisation Techniques for Fuel Cells.....	4	9
EEE4103F	Nuclear Power Sources.....	12	8
END5049Z	Research Communication & Methods.....	16	9
MEC5035Z	Project Management.....	20	9

Doctoral Programmes

Doctor of Philosophy

[ED001CHE01]

ED001 Doctor of Philosophy is a Research Degree

Core Course

Code	Course	NQF Credits	HEQSF Level
CHE6000W	Thesis.....	360	10

Course descriptions are set out in the section Courses Offered. The course code abbreviation for Chemical Engineering is CHE.

Course Outlines

CHE4054Z ENVIRONMENTAL STEWARDSHIP IN MINING & MINERALS BENEFICIATION

12 NQF credits at HEQSF level 8

Convener: Professor H von Blottnitz

Course outline:

Mining in Africa, as in the rest of the world has an adverse impact on the environment. Understanding environmental challenges relevant to the mineral industry, with emphasis on the relationship between mining and minerals beneficiation activities and environmental impact categories is cardinal. In this course students will be introduced to environmental issues related to mining industries as well as environmental legislation, guidelines and best practices. It will provide exposure to the mining world and will offer students the opportunity to conduct case studies on real mine sites.

DP requirements: None

Assessment: Group assignments (20%), individual case-study (20%), individual assignment (60%).
Entrance is limited to the MPhil specialising in Sustainable Mineral Resource Development

CHE4055X PRACTICAL TRAINING IN SUSTAINABLE DEVELOPMENT

0 NQF credits at HEQSF level 8

Convener: Professor H von Blottnitz

Course outline:

This course is grounded in the realizations that sustainable development requires professionals to be able to negotiate disciplinary truth boundaries so as to minimize externalization of costs and damages to 3rd parties or future generations; and requires an understanding of the complexity of coupled social-ecological systems, which can only partly be learnt in the classroom. This course aims to ground learning not just in theory but also in the evolving practice of sustainable development in Africa. Students are requested to register for a practical training period of two weeks or more, with an accredited host, resulting in a reflective report.

DP requirements: None

Assessment: Coursework 100% *Entrance is limited to the MPhil specialising in Sustainable Mineral Resource Development*

CHE4056Z SPECIAL TOPICS IN SUSTAINABLE DEVELOPMENT

16 NQF credits at HEQSF level 8

Convener: Professor STL Harrison

Course outline:

This course focuses on the rise to global prominence of the challenge of sustainability in general and sustainable development in particular. Course topics include: the meaning of sustainability and sustainable development; key elements of the environmental crisis; key elements of the global economy and the nature of inequality; an introduction to deep ecology; fault lines and application.

DP requirements: None

Assessment: Coursework 100% *Entrance is limited to the MPhil specialising in Sustainable Mineral Resource Development*

CHE5000W MASTERS DISSERTATION IN CHEMICAL ENGINEERING

180 NQF credits at HEQSF level 9

Convener: None

Co-requisites: CHE5055Z

Course outline:

The dissertation should incorporate any or all of the following: design of all or part of an engineering project to a specification involving advanced concepts and theoretical principles; a

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research project of a theoretical or practical nature; a critical review of a specified topic based upon a comprehensive search of the literature or available data; development of an item of equipment or a technique involving novel features or advanced design; or any other study acceptable to the Faculty.

DP requirements: None

Assessment: Written work counts 100%.

CHE5002W DISSERTATION CHEMICAL ENGINEERING

120 NQF credits at HEQSF level 9

Convener: None

Course entry requirements: CHE5055Z, DP in CHE5082Z.

Course outline:

The dissertation should incorporate any or all of the following: design of all or part of an engineering project to a specification involving advanced concepts and theoretical principles; a research project of a theoretical or practical nature; a critical review of a specified topic based upon a comprehensive search of the literature or available data; development of an item of equipment or a technique involving novel features or advanced design.

DP requirements: None

Assessment: Written work counts 100%.

CHE5030Z ADVANCED ENGINEERING STATISTICS I

8 NQF credits at HEQSF level 9

Convener: Professor K Möller

Course entry requirements: BSc (Engineering) (Chemical Engineering)

Course outline:

This course covers advanced engineering statistics. Topics include: Conducting a physical experiment, random variables and variation, making inference on random variables, normal distribution, confidence intervals. Design and analysis of experiments: sequential design, factorial designs, fractional factorial designs, response surface designs, mixture designs, optimal design. Nonlinear model fitting, nonlinear optimal design, application to laboratory and industrial data.

DP requirements: Submission of all projects and/or assignments with all questions/sections duly attempted

Assessment: 50% weighted average of all projects and assignments

CHE5033Z APPLIED MATHEMATICS & MODELING II

8 NQF credits at HEQSF level 9

Course outline:

This course covers applied mathematics and modelling. Topics include: non-linear multivariable parameter estimation, formulation of objective functions, optimisation (NLP), single variable, multivariable, BFGS, Nelder and Mead, Levenberg-Marquardt, sequential quadratic programming (QP&SQP), mix-integer non-linear optimisation (MINLP), unconstrained, constrained, inequalities, Lagrange multipliers, sensitivity analysis, and examples.

Assessment: Projects and assignments (50% for each project and assignment to pass course).

CHE5047Z INTRODUCTION TO MOLECULAR MODELING

8 NQF credits at HEQSF level 9

Course outline:

This course develops an advanced understanding of molecular modelling of solids and fluid-phase components of interest to catalysis and other fields. The course provides background theoretical understanding of molecular modelling as well as subject specific experience with the use of the leading commercial modelling software. Included are the building of molecular structures ab initio, the use of data libraries as well as the use of various force-field energy minimisation techniques.

DP requirements: None

Assessment: Examination 2 hours.

CHE5048Z CRYSTALLISATION AND PRECIPITATION

12 NQF credits at HEQSF level 9

Convener: Professor AE Lewis

Course outline:

Crystallisation and precipitation are both purification and separation processes, and takes place through a solid phase being created from a liquid phase. The course covers crystallization methods and supersaturation, particle size distribution (PSD), crystal morphology, mother liquor inclusions, uptake of impurities, primary nucleation, growth mechanisms and growth rate expressions, the population balance equation, agglomeration and special considerations for precipitation.

DP requirements: None

Assessment: Assignments and Projects

CHE5051Z MICROBIAL PHYSIOLOGY AND DYNAMICS

8 NQF credits at HEQSF level 9

Convener: Dr R Huddy

Course entry requirements: BSc(Eng) or equivalent four year BSc(Hons) degree.

Course outline:

This course in microbial physiology and dynamics covers: fundamentals of microbiology, macromolecules and metabolism; metabolic engineering; microbial media and culture maintenance; and gene expression and control.

DP requirements: None

Assessment: Examination 3 hours, assignments.

CHE5054Z BIOTECHNOLOGY LABORATORY

8 NQF credits at HEQSF level 9

Convener: TBA

Course entry requirements: BSc (Eng) or BSc (Hons) degree or equivalent

Course outline:

This course aims to develop an understanding of basic microbiology, bioreactor technology, brewing, protein extraction and electrophoresis, DNA extraction, PCR, fluorescence microscopy, enzyme kinetics, and biotransformations.

DP requirements: None

Assessment: Assignments and practical examination.

CHE5055Z RESEARCH COMMUNICATION & METHODOLOGY

16 NQF credits at HEQSF level 9; 1 Final report..

Convener: Professor STL Harrison

Course entry requirements: BSc (Eng) or BSc (Hons) degree or equivalent

Course outline:

The aim of this course is to provide postgraduate students with the competency to execute meaningful research in a structured way, to critically analyse the results of this research and to communicate these results effectively. The course topics include: research philosophy, research planning, hypothesis development and research methodology; literature review skills; research ethics; research communication and related technical skills; experimental practice; structuring, writing and presentation of scientific outputs. The assignments include: oral presentation of seminars, scientific and technical writing tasks, experimental design tasks and literature review. The final examination comprises the compilation and presentation of the final report which is a complete research proposal.

DP requirements: Completion of all assignments and the final report (100%).

Assessment: Assignments and final report.

CHE5064Z SUSTAINABILITY IN CHEMICAL ENGINEERING

8 NQF credits at HEQSF level 9

Convener: Professor STL Harrison**Course entry requirements:** BSc (Eng) or BSc (Hons) degree or equivalent**Course outline:**

Sustainability is fast becoming a major factor in decision making in most industries employing chemical engineering graduates. Since the IChemE and its sister associations signed the London Communiqué in 1997, sustainability has become understood as a key design and operation criterion for chemical engineers to consider. This course seeks to provide graduate students with an awareness of the issues surrounding a sustainable process industry and an appreciation for its importance. The course will examine the central role of chemical engineering in achieving balance amongst economic, environmental, and social benefits and impacts for projects conducted by companies operating in the oil, chemicals, minerals and energy sectors, and will address related challenges of intensive agriculture and provision of water. It seeks to go further to provide a framework and a set of tools which will assist the process engineer in providing rational input in terms of sustainability into decision making, with quantification wherever possible.

DP requirements: None**Assessment:** Examination and assignments.

CHE5069Z ADVANCED THERMODYNAMICS AND SEPARATION

8 NQF credits at HEQSF level 9

Course entry requirements: BSc(Eng).**Course outline:**

This course aims to develop an understanding of advanced thermodynamics & separation processes. Topics include: multiphase equilibria: equations of state, activity coefficient models, gas-solid and liquid-solid systems, Gibbs free energy minimisation. Separations technology: azeotropes, residue curve/distillation curve analysis, complex separations, membranes, adsorption, reactive separations. Multi-component mass transfer: application of Maxwell-Stefan theory to separation systems.

DP requirements: None**Assessment:** Projects and assignments (50% for each project and assignment to pass course).

CHE5070Z ADVANCED BIOPROCESS ENGINEERING

16 NQF credits at HEQSF level 9

Convener: Professor STL Harrison**Course entry requirements:** BSc(Eng) or equivalent four year BSc(Hons) degree.**Course outline:**

This course is an advanced introduction to bioprocess design. Topics include: Stoichiometry of microbial growth and product formation. Mixing and oxygen transfer. Bioreactor design and scale up. Sterilisation. Material and energy balances for microbial systems. Biokinetic analysis of batch, fed-batch and continuous systems. Mixed cultures and mixed culture kinetics. Downstream processing. Bioprocess analysis. Environmental impact of bioprocesses.

DP requirements: Satisfactory completion of all projects and assignments.**Assessment:** Examination 3 hours, projects and assignments.

CHE5072Z FUNDAMENTALS OF PROCESS MODELING

4 NQF credits at HEQSF level 9

Course outline:

This advanced course covers the fundamentals of process modelling. Topics include: micro-, meso-, macro-scale modelling; population balance modelling; dynamics and stability of chemical systems.

DP requirements: Attendance 70%.**Assessment:** Project and/or examination.

CHE5078Z NUMERICAL METHODS FOR ENGINEERS

16 NQF credits at HEQSF level 9

Course entry requirements: BSc(Eng), BSc(Hons) with applied mathematics major.

Course outline:

This course in advanced numerical methods for engineers covers: computer arithmetic, linear equations (transformations, SVD), non-linear equations (quasi-newton's methods, continuation), ODEs (explicit, implicit, BDF, implicit Runge-Kutta), BVPs (collocation, finite differences, shooting method, finite elements), DAEs (index, implicit solvers), PDEs (collocation, finite differences, finite elements, iterative methods), model regression (least squares, variance, bootstrap, parameter estimation), and parametric sensitivity analysis (transient, steady state).

DP requirements: None

Assessment: Projects and assignments (50% for each project and assignment to pass course).

CHE5082Z DISSERTATION PREPARATION

DP requirement for entry to CHE5002W.

0 NQF credits at HEQSF level 9

Co-requisites: CHE5055Z

Course outline:

The aim of this course is to allow a student to undertake preparatory work for the 120 credit dissertation (CHE5002W). Work required may include ensuring that research infrastructure (e.g. apparatus etc.) is or will be in place, setting up of models, collection of data. The student should maintain regular contact with his/her supervisor in order to show evidence of suitable progress towards these aims. The supervisor must indicate satisfactory fulfilment of the course aims prior to the student proceeding to the dissertation.

DP requirements: None

CHE5083Z TRANSLATING TECHNOLOGY FROM THE LABORATORY TO THE MARKETPLACE

8 NQF credits at HEQSF level 9

Convener: Professor STL Harrison

Course entry requirements: BSc (Eng) or BSc (Hons) or equivalent

Course outline:

This course aims to develop an understanding of how to translate technology from the laboratory to the marketplace. Topics covered include technology commercialisation; intellectual property; start-up companies (structure, resourcing); entrepreneurial resources; introduction to entrepreneurial finance and funding; business models specific to biotechnology; understanding the components of a business plan; and market research.

DP requirements: Satisfactory completion of 80% assignments

Assessment: Year mark.

CHE5086Z ELECTROCHEM CHARACTERISATION TECHNIQUES FOR FUEL CELLS

4 NQF credits at HEQSF level 9; block release.

Convener: Associate Professor P Leveque

Course entry requirements: BSc (Eng) or equivalent four years BSc (Hons)

Course outline:

Basics of electrochemistry: electrode reactions, electron transfer, double layer, design of experiment. Platinum as electrocatalyst: behaviour in bulk and as nanoparticle. The role of carbon and other supports for fuel cell catalysts. Theoretical and practical aspects of cyclic voltammetry, electrochemical impedance spectroscopy, rotation disk electrode, polarisation curve, current interrupt and linear sweep voltammetry. Overview of selected physical/chemical characterisation techniques and their application in fuel cell research.

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DP requirements: None

Assessment: Coursework 30%, Examination 70%

CHE5087Z RESEARCH METHODOLOGY

16 NQF credits at HEQSF level 9; block release.

Convener: Professor STL Harrison

Course outline:

This course aims to provide postgraduate students with competency to execute meaningful research in a structured way, to critically analyse the results of this research and to communicate these results effectively. To achieve this, the course topics include research philosophy; research planning, hypothesis development and research methodology; literature review skills; research ethics; research communication and related technical skills; structuring, writing and presentation of research outputs.

Entrance is limited to students registered for the M Phil specialising in Sustainable Mineral Resource Development offered by the University of Cape Town and the equivalent Master of Mineral Science Degree in Sustainable Mineral Resources Development, offered by the University of Zambia.

DP requirements: None

Assessment: Coursework 100%.

CHE5088Z INTRODUCTION TO HETEROGENEOUS CATALYSIS RESEARCH

8 NQF credits at HEQSF level 9

Convener: Associate Professor N Fischer

Course entry requirements: BSc Honours in Science or BSc (Eng) or equivalent.

Co-requisites: None

Course outline:

This course aims to facilitate the connection between high level theory and practical application, for new MSc students in the field of heterogeneous catalysis research. Included are safety aspects specific to laboratories in the Centre for Catalysis Research, the design of test units (including material section, valve design, and temperature/pressure control), and the preparation of various types of heterogeneous catalysts.

DP requirements: Pass presentation on experimental plan for heterogeneous catalysis preparation practical (pass/fail principle, no grades).

Assessment: Written report on heterogeneous catalyst preparation practical (40%); Written exam on course including safety aspects, planning/design/operation of rigs and heterogeneous catalysis preparation (60%).

CHE5089Z CHARACTERIZATION TECHNIQUES FOR CATALYSIS RESEARCH

12 NQF credits at HEQSF level 9

Convener: Associate Professor N Fischer

Course entry requirements: BSc Honours in Science or BSc (Eng) or equivalent.

Co-requisites: None

Course outline:

This course aims to facilitate the connection between high level theory and practical application for new MSc students in the field of heterogeneous catalysis characterization techniques. It includes common techniques available in or associated with the laboratories in the Centre for Catalysis Research such as temperature programmed techniques, elemental analysis methods, electron microscopy, X-ray and light based techniques (i.e. Raman and infra-red spectroscopy), gas chromatography and the introduction of more specialized methods such as X-ray absorption, solid state NMR and surface science techniques.

DP requirements: None

CHEMICAL ENGINEERING

The Department offers the following postgraduate programmes in coursework, in addition to MSc and PhD programmes:

Bioprocess Engineering
Catalysis and Catalytic Processing
Minerals Beneficiation

Research Entities:

Centre for Bioprocess Engineering Research
Catalysis Institute
Centre for Minerals Research
Crystallisation and Precipitation Research Unit
DST-NRF Centre of Excellence in Catalysis
Minerals to Metals
National Hydrogen Catalysis Competence Centre

The Department of Chemical Engineering is situated in the Chemical Engineering Building, which is on Upper Campus. Access to the Building is from South Lane, off Mandela Circle.

Website: www.chemeng.uct.ac.za

Staff

Professor and Head of Department

A Mainza, BSc(Eng)Chem *UNZA* PhD *Cape Town*

Professors

M Claeys, Dipl Ing(Chem Eng) Dr Ing *Karlsruhe*
DA Deglon, BSc(Eng) *Witwatersrand* MBA PhD *Cape Town* MSAIMM FSAAE
JCQ Fletcher, BSc(Eng)Chem PhD *Cape Town* MACS FSAAE
STL Harrison, BSc(Hons) *Cape Town* PhD *Cantab* MSAIChE SASM FSAIMM FSAAE ASSAF
FWISA
PJ Kooyman, Drs Chemie (MSc) *Leiden* PhD ChemE *Delft University of Technology* MSAIChE
AE Lewis, PrEng BSc(Eng)Chem MSc PhD *Cape Town* FSAIChE FSAIMM MASSAF FSAAE
FICHEM
KP Möller, BSc(Eng)Chem PhD *Cape Town*
J Petersen, BSc(Eng)Chem *Witwatersrand* PhD *Cape Town* MSAIMM
E van Steen, MSc(Eng) *Eindhoven* Dr.-Ing. *Karlsruhe* FSAIChE FSAAE AFICHEM
HB von Blottnitz, PrEng BSc(Eng)Chem *Cape Town* BSc(Hons) *UNISA* MSc *Cape Town* Dr Ing
RWTHAachen MSAIChE

Associate Professors

M Becker, BSc(Hons) Geology MSc *Cape Town* PhD *Pretoria*
JL Broadhurst, BSc(Hons) MSc *Port Elizabeth* PhD *Cape Town*
KC Corin, BSc(Hons) PhD *Cape Town*
NF Fischer, Dipl.-Ing.(Chem Eng) *Karlsruhe* PhD *Cape Town*
A Isafiade, BSc(Hons) *Ilorin* MSc *Ife* PhD *Cape Town* AMICHEM (Director of Postgraduate Studies)
PBJ Levecque, MSc(Eng) PhD *Leuven*

Emeritus Professors

J-P Franzidis, BSc(Eng) MSc Cape Town PhD *Open* MSAiChE MSAiMM
 CT O'Connor, PrEng BSc *UNISA* STD *Natal* BSc(Hons) PhD *Cape Town* DEng *Stell* FSAiMM
 FSAiChE FSAAE FRSSAf

Honorary Professors

JM Case, BSc(Hons) *Stellenbosch* HDE MSc *Cape Town* Med *Leeds* PhD *Monash* MASSAf
 I Govender, BSc *UDW* BSc(Hons)Physics PhD *Cape Town* HDE *UNISA*
 GJ Hutchings BSc(Chem) PhD *UCL* DSC (Heterogeneous Catalysis) *London* FICHEM FRS CBE
 MJ Nicol, BSc(Hons) PhD *Witwatersrand* FSAiMM, FAUSiMM
 JW Niemantsverdriet, BSc (Phys+Math) MSc *Amsterdam* PhD *Delft* (TechSciences)
 JG Petrie, CEng BSc(Eng)Chem *Cape Town* MSc *Houston* PhD *Cape Town* FICHEM

Honorary Associate Professor

B Cohen, BSc(Eng)Chem PhD *Cape Town*

Adjunct Professors

B J Chicksen, MBChB *Harare* FCP (SA) *Durban* MBA *Johannesburg*
 P Dempsey, NHD Metallurgy *Wits Technikon* BSc *UNISA* MDP *UNISA*
 CM Digby, BA Hons(Econ) *Trinity College Dublin* MA(Econ) *British Columbia*
 MSc(Environent) *London School of Economics and Political Science*
 AS Lambert, BSc(Hons) Extractive Metallurgy *Glasgow* FSAiMM
 JW Mann, BSc(Eng) Extractive Metallurgy *Witwatersrand* MBL *UNISA*
 R Schouwstra, BSc(Hons) *NWU* MSc *Johannesburg* DSc *NWU*
 MH Solomon, BSc(Eng)Mining, *Witwatersrand*, FSAiMM, FIQ, Mine Manager's Certificate of
 Competency (Metalliferous), MDP(Mining) *South Africa*
 WA van Dyk, BEng (Chemical, Extractive Metallurgy) PhD *Stellenbosch*
 DW Wright, BSc(Eng)Chem *Natal* MSAiChE FSAAE

Adjunct Associate Professor

PJ Notten, BSc(Eng)Chem PhD *Cape Town*

Senior Lecturers

L Bbosa, BSc(Eng)Elec-Mech MSc PhD *Cape Town* MSAiMM
 MA Fagan-Endres, BSc(Eng)Chem *Cape Town* PhD *Cantab*
 HR Heydenrych, BSc(Eng)Chem MSc *Cape Town*
 TP Mokone BSc Hons(Chem) *UFS* MSc *UFS* PhD(Chem Eng) *Cape Town*
 S Tai, BSc(Hons)*UMIST* MSc PhD *Delft* (Director of Undergraduate Studies)

Lecturer

T Rampai, BSc(Hons) MSc *Cape Town*

Contract Lecturers

E Govender-Opitz, BSc(Eng)Chem PhD *Cape Town*
 MS Manono, BSc(Eng)Chem MSc *Cape Town* PGDBM Regenesys, AMiChE, MSAiChE,
 MSAiMM
 MN Naidoo, BSc(Eng)Chem Eng *UKZN*
 T van Heerden, BSc(Eng)Chem MSc *Cape Town*

Honorary Research Associates

MJ Griffiths, BSc(Med)(Hons) MSc PhD *Cape Town*
 M Johnstone Robertson, BSc(Eng)Chem PhD *Cape Town*
 MA Petersen, BSc MSc *Cape Town* PhD *Cantab*
 RP van Hille, BSc MSc PhD *Rhodes*

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Chief Research Officer

MC Harris, BSc(Eng)Chem MSc *Cape Town*

Senior Research Officers

K Carden, BSc(Chem) MSc PhD *Cape Town FWISA*
BJ McFadzean, BSc(Hons) MSc *Port Elizabeth PhD NMMU*
APP van der Westhuizen, BEng *Stellenbosch MSc Cape Town*
JG Wiese NDip *CPUT MSc Cape Town*

Junior Research Fellow

J Waters, BTech(Chem Eng) *Cape Technikon MSc Cape Town*

Research Officers

PA Bepswa, BSc(Eng)Metallurgical *Zimbabwe PhD Cape Town*
RJ Huddy, BSc(Hons) PhD *Cape Town*
A Kotsiopoulos, BScChem MSc PhD *Cape Town*
N Hussain, BSc(Eng)Chem MSc *Cape Town*
NTJ Luchters, BTech *Leiden MSc Cape Town*
R Mohamed, BSc BScHons(Chemistry) MSc *NMMU PhD(Chem Eng) Cape Town*

Principal Technical Officer

HJ Macke, Dip Mechanical Engineering Technician, *Germany*

Chief Technical Officers

MA Jakoet, BSc(Eng) Mechatronics *Cape Town*
P Johnston, BSc *Cape Town*

Senior Technical Officers

RB Cupido, NDip(Analytical Chemistry) BTech(Chemistry) MTech(Chem) *CPUT*
G Kaufmann, PGDip *Cape Town Mtech(Chem) BTech(Chem) CPUT MSRM EMT-B Cape Town*
WP Koorts BTech(Chem Eng) MTech *CPUT*
CA Le Roux, NDip *CPUT BTech(Chem) UNISA*
IE Ngoma, BTech(Biotech) *TUT MTech CPUT*

Technical Officers

DJ Bramble
M Smart, BScHons MSc *Stellenbosch PhD Cape Town*

Chief Scientific Officer

J Chivavava, B(Eng) *NUST MSc(Eng) Cape Town*

Senior Scientific Officers

T Chivengwa, BSc(Eng) MSc *Cape Town*
AS Geldenhuys, BEng (Chem) *Stellenbosch*
T Khoza, BSc(Eng) Chem MSc(Eng) Chem *Cape Town*
Z Le Riche, ND(Analytical Chemistry) *CPUT*
M Lisso, BSc(Eng) Chem MSc *Cape Town*
MC Richter, BSc(Hons) Physics MSc PhD *Cape Town*
GA Yorath, BSc(Hons) Mineral Processing Technology *Cornwall*

Scientific Officer

RE Van Schalkwyk, BTech(Chem Eng) *CPUT*

Department Laboratory ManagerA Mentoor, BSc(Hons) MSc *Stellenbosch***Analytical Laboratory Manager**S Govender, BSc(AppChem) Hons(Chem) MSc *UKZN***Department Manager**

SI Pillay

Building Supervisor

E Matthews

Administrative Staff

B Cloete (Undergraduate Administrator)

B Davids (Postgraduate Administrator)

N Davids (Finance Assistant)

S Jeppie (Purchaser)

N Dili (Receptionist)

K Mfundisi (Administrative Assistant)

The Department offers both undergraduate and postgraduate programmes in Chemical Engineering. The undergraduate programme draws top school leavers from South Africa and further afield, with an annual intake of approximately 140 students. Graduates from this programme are highly sought-after in a wide variety of industries. The Department has dynamic research programmes and students who have obtained satisfactory results in their undergraduate courses are encouraged to return for postgraduate study. The Department's research activities are at present centered on:

- Biological leaching of mineral ores, with work concentrated on the fundamental processes involved
- Bioprocess engineering focused on biotransformation, process design, process kinetics, novel bioprocesses and the recovery of biological product;
- Catalysis research aimed at synthesis, characterisation and modelling of heterogeneous catalysts and their application in a variety of reactions and reactor types
- Crystallization and precipitation research focusing on metal recovery in mineral processing and metal removal for environmental protection and crystallization for water treatment
- Educational research aimed at improving the quality of undergraduate teaching and learning;
- Environmental process engineering, both at a conceptual and a practical level
- Hydrogen and fuel cell technologies focusing on fuel processing catalysis and devices, electrodes development and fuel cell and stack development
- Hydrometallurgy for metal extraction
- Minerals processing research focused on milling, classification and flotation of ores;
- Process modelling and optimization
- Process synthesis featuring the application of pinch technology to heat and mass transfer systems as well as the control of process systems
- Value recovery from waste, contributing to industrial ecology and the circular economy
- Water remediation, treatment, recovery and footprinting

Postgraduate Programmes

Master's Programmes

MSc in Engineering specialising in Bioprocess Engineering [EM024CHE01]

Professor and Convener:

STL Harrison, BSc(Hons) *Cape Town* PhD *Cantab* MSAIChe SASM FSAIMM FSAAE ASSAF
FWISA

Core Courses

Code	Course	NQF Credits	HEQSF Level
CHE5082Z	Dissertation Preparation (in 1st year)	0	9
CHE5002W	Dissertation Chemical Engineering	120	9
CHE5051Z	Microbial Physiology & Dynamics	8	9
CHE5070Z	Advanced Bioprocess Engineering	16	9
CHE5049Z	Chemical Engineering Topics for Scientists	16	9
CHE5054Z	Biotechnology Laboratory	8	9
CHE5055Z	Research Communication & Methodology	16	9
END5050X	Master's Journal Paper	0	9
	Minimum total credits	180	

Notes

CHE5051Z is a core course for engineering graduates.

CHE5049Z is a core courses for life science graduates, but may be replaced by an equivalent course. Physical Science graduates will complete CHE5051Z and/or CHE5049Z or equivalent courses, dependent on their previous studies.

Elective or optional courses: 4 – 12 credits

MSc in Engineering specialising in Catalysis and Catalytic Processing [EM024CHE01]

Associate Professor and Convener:

N Fischer Diplom Ingenieur *Karlsruhe* PhD *Cape Town*

Core Courses for Chemical Engineering Graduates (students who have completed CHE4067F)

Code	Course	NQF Credits	HEQSF Level
CHE5002W	Dissertation Chemical Engineering	120	9
CHE5088Z	Introduction to Heterogeneous Catalysis Research	8	9
CHE5089Z	Characterisation Techniques for Catalysis Research	12	9
CHE5055Z	Research Communication & Methodology	16	9
CHE5082Z	Dissertation Preparation	0	9
END5050X	Master's journal paper	0	9
	Optional courses	24	9
	Minimum total credits	180	

Core Courses for Science Graduates (students who have not completed CHE4067F)

Code	Course	NQF Credits	HEQSF Level
CHE5002W	Dissertation Chemical Engineering	120	9
CHE4067F	Heterogeneous Catalysis	16	9
CHE5088Z	Introduction to Heterogeneous Catalysis Research	8	9

Code	Course	NQF Credits	HEQSF Level
CHE5089Z	Characterisation Techniques for Catalysis Research.....	12	9
CHE5055Z	Research Communication & Methodology	16	9
CHE5082Z	Dissertation Preparation	0	9
END5050X	Master's journal paper.....	0	9
	Optional courses	8	9
	Minimum total credits	180	

Master of Philosophy specialising in Sustainable Mineral Resource Development [EM026CHE05]

Professors and Co-conveners:

JL Broadhurst, BSc(Hons) MSc *Port Elizabeth* PhD *Cape Town*

Mining in Africa, as in the rest of the world, has changed from simply balancing production targets with cost control to a complex set of interrelationships including safety, health, the environment, sustainable development and proactive stakeholder management. This programme is aimed at providing an interdisciplinary postgraduate qualification that highlights the critical factors of sustainable development in the context of mining and minerals processing in Africa; including an understanding of, and a sensitivity and progressive approach to, managing and interacting with communities, environmental challenges, safety cultures, health-related issues and regulatory frameworks.

This trans-disciplinary Master of Philosophy (MPhil) Degree is offered through the Minerals to Metals Research Initiative within the Department of Chemical Engineering at UCT.

Students will complete the research component of the degree at UCT under supervision, and complete course work at UCT (including the UCT Graduate School of Business), the University of Stellenbosch and the University of Zambia. Credit and exemption will be granted for courses taken at other institutions, as shown below.

A candidate for the Master's specialising in Sustainable Mineral Resource Development shall complete coursework to the minimum of 60 credits, which includes all core courses listed below, and a 120 credit dissertation.

Code	Course	NQF Credits	HEQSF Level
CHE5002Z	Master's Dissertation: Chemical Engineering	120	9
CHE5087Z	Research Methodology	16	9
CHE5082Z	Dissertation Preparation	0	9
END5050X	Master's Journal Paper.....	0	9
CHE4054Z*	Environmental Stewardship in Mining & Minerals Beneficiation	12	8
CHE4055X	Practical Training in Sustainable Development.....	0	8
CHE4056Z*	Special Topics in Sustainable Development.....	16	8
GSB4264Z	Strategic Engagement Practice	16	8
	Total credits per year	180	

* indicates core courses offered elsewhere for which credit and exemption will be granted.

University of Zambia (School of Mines)

'Environmental Stewardship in Mining & Minerals Beneficiation' (credit and exemption CHE4054Z)

University of Stellenbosch (Sustainability Institute)

'Advanced Introduction to Sustainable Development' (credit and exemption CHE4056Z)

Optional Courses for all Postgraduate Programmes

[EM_CHE_OPTIONAL COURSES]

In addition to the courses listed below, the core courses of the three programmes above may be used as optional courses in the other programmes.

Code	Course	NQF Credits	HEQSF Level
CHE5022Z	Introduction to Catalysis.....	16	9
CHE5030Z	Advanced Engineering Statistics I.....	8	9
CHE5040Z	Fuels & Chemicals from Oil.....	12	9
CHE5041Z	Instrumental Analysis Part A - General Measurement.....	4	9
CHE5042Z	Instrumental Analysis Part B - Chromatography.....	4	9
CHE5043Z	Instrumental Analysis Part C - Spectroscopy.....	4	9
CHE5045Z	Fuels & Chemicals from Coal & Syngas.....	12	9
CHE5047Z	Molecular Modelling.....	8	9
CHE5048Z	Crystallization and Precipitation.....	12	9
CHE5051Z	Microbial Physiology and Dynamics.....	8	9
CHE5052Z	Molecular Biology and Biocatalysis.....	8	9
CHE5054Z	Biotechnology Laboratory.....	8	9
CHE5064Z	Sustainability in Chemical Engineering.....	8	9
CHE5069Z	Advanced Thermodynamics and Separation Processes.....	8	9
CHE5070Z	Advanced Bioprocess Engineering.....	16	9
CHE5072Z	Fundamentals of Process Modelling.....	4	9
CHE5078Z	Advanced Numerical Methods for Engineers.....	16	9
CHE5079Z	Integrated Analysis of Mineral Beneficiation Systems.....	16	9
CHE5083Z	Translating Technology from the Laboratory to the Marketplace.....	8	9
CHE5085Z	Hydrogen Technology.....	8	9
CHE5086Z	Electrochemical Characterisation Techniques for Fuel Cells.....	4	9
EEE4103F	Nuclear Power Sources.....	12	8
END5049Z	Research Communication & Methods.....	16	9
MEC5035Z	Project Management.....	20	9

Doctoral Programmes

Doctor of Philosophy

[ED001CHE01]

ED001 Doctor of Philosophy is a Research Degree

Core Course

Code	Course	NQF Credits	HEQSF Level
CHE6000W	Thesis.....	360	10

Course descriptions are set out in the section Courses Offered. The course code abbreviation for Chemical Engineering is CHE.

Course Outlines

CHE4054Z ENVIRONMENTAL STEWARDSHIP IN MINING & MINERALS BENEFICIATION

12 NQF credits at HEQSF level 8

Convener: Professor H von Blottnitz

Course outline:

Mining in Africa, as in the rest of the world has an adverse impact on the environment. Understanding environmental challenges relevant to the mineral industry, with emphasis on the relationship between mining and minerals beneficiation activities and environmental impact categories is cardinal. In this course students will be introduced to environmental issues related to mining industries as well as environmental legislation, guidelines and best practices. It will provide exposure to the mining world and will offer students the opportunity to conduct case studies on real mine sites.

DP requirements: None

Assessment: Group assignments (20%), individual case-study (20%), individual assignment (60%).
Entrance is limited to the MPhil specialising in Sustainable Mineral Resource Development

CHE4055X PRACTICAL TRAINING IN SUSTAINABLE DEVELOPMENT

0 NQF credits at HEQSF level 8

Convener: Professor H von Blottnitz

Course outline:

This course is grounded in the realizations that sustainable development requires professionals to be able to negotiate disciplinary truth boundaries so as to minimize externalization of costs and damages to 3rd parties or future generations; and requires an understanding of the complexity of coupled social-ecological systems, which can only partly be learnt in the classroom. This course aims to ground learning not just in theory but also in the evolving practice of sustainable development in Africa. Students are requested to register for a practical training period of two weeks or more, with an accredited host, resulting in a reflective report.

DP requirements: None

Assessment: Coursework 100% *Entrance is limited to the MPhil specialising in Sustainable Mineral Resource Development*

CHE4056Z SPECIAL TOPICS IN SUSTAINABLE DEVELOPMENT

16 NQF credits at HEQSF level 8

Convener: Professor STL Harrison

Course outline:

This course focuses on the rise to global prominence of the challenge of sustainability in general and sustainable development in particular. Course topics include: the meaning of sustainability and sustainable development; key elements of the environmental crisis; key elements of the global economy and the nature of inequality; an introduction to deep ecology; fault lines and application.

DP requirements: None

Assessment: Coursework 100% *Entrance is limited to the MPhil specialising in Sustainable Mineral Resource Development*

CHE5000W MASTERS DISSERTATION IN CHEMICAL ENGINEERING

180 NQF credits at HEQSF level 9

Convener: None

Co-requisites: CHE5055Z

Course outline:

The dissertation should incorporate any or all of the following: design of all or part of an engineering project to a specification involving advanced concepts and theoretical principles; a

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research project of a theoretical or practical nature; a critical review of a specified topic based upon a comprehensive search of the literature or available data; development of an item of equipment or a technique involving novel features or advanced design; or any other study acceptable to the Faculty.

DP requirements: None

Assessment: Written work counts 100%.

CHE5002W DISSERTATION CHEMICAL ENGINEERING

120 NQF credits at HEQSF level 9

Convener: None

Course entry requirements: CHE5055Z, DP in CHE5082Z.

Course outline:

The dissertation should incorporate any or all of the following: design of all or part of an engineering project to a specification involving advanced concepts and theoretical principles; a research project of a theoretical or practical nature; a critical review of a specified topic based upon a comprehensive search of the literature or available data; development of an item of equipment or a technique involving novel features or advanced design.

DP requirements: None

Assessment: Written work counts 100%.

CHE5030Z ADVANCED ENGINEERING STATISTICS I

8 NQF credits at HEQSF level 9

Convener: Professor K Möller

Course entry requirements: BSc (Engineering) (Chemical Engineering)

Course outline:

This course covers advanced engineering statistics. Topics include: Conducting a physical experiment, random variables and variation, making inference on random variables, normal distribution, confidence intervals. Design and analysis of experiments: sequential design, factorial designs, fractional factorial designs, response surface designs, mixture designs, optimal design. Nonlinear model fitting, nonlinear optimal design, application to laboratory and industrial data.

DP requirements: Submission of all projects and/or assignments with all questions/sections duly attempted

Assessment: 50% weighted average of all projects and assignments

CHE5033Z APPLIED MATHEMATICS & MODELING II

8 NQF credits at HEQSF level 9

Course outline:

This course covers applied mathematics and modelling. Topics include: non-linear multivariable parameter estimation, formulation of objective functions, optimisation (NLP), single variable, multivariable, BFGS, Nelder and Mead, Levenberg-Marquardt, sequential quadratic programming (QP&SQP), mix-integer non-linear optimisation (MINLP), unconstrained, constrained, inequalities, Lagrange multipliers, sensitivity analysis, and examples.

Assessment: Projects and assignments (50% for each project and assignment to pass course).

CHE5047Z INTRODUCTION TO MOLECULAR MODELING

8 NQF credits at HEQSF level 9

Course outline:

This course develops an advanced understanding of molecular modelling of solids and fluid-phase components of interest to catalysis and other fields. The course provides background theoretical understanding of molecular modelling as well as subject specific experience with the use of the leading commercial modelling software. Included are the building of molecular structures ab initio, the use of data libraries as well as the use of various force-field energy minimisation techniques.

DP requirements: None

Assessment: Examination 2 hours.

CHE5048Z CRYSTALLISATION AND PRECIPITATION

12 NQF credits at HEQSF level 9

Convener: Professor AE Lewis

Course outline:

Crystallisation and precipitation are both purification and separation processes, and takes place through a solid phase being created from a liquid phase. The course covers crystallization methods and supersaturation, particle size distribution (PSD), crystal morphology, mother liquor inclusions, uptake of impurities, primary nucleation, growth mechanisms and growth rate expressions, the population balance equation, agglomeration and special considerations for precipitation.

DP requirements: None

Assessment: Assignments and Projects

CHE5051Z MICROBIAL PHYSIOLOGY AND DYNAMICS

8 NQF credits at HEQSF level 9

Convener: Dr R Huddy

Course entry requirements: BSc(Eng) or equivalent four year BSc(Hons) degree.

Course outline:

This course in microbial physiology and dynamics covers: fundamentals of microbiology, macromolecules and metabolism; metabolic engineering; microbial media and culture maintenance; and gene expression and control.

DP requirements: None

Assessment: Examination 3 hours, assignments.

CHE5054Z BIOTECHNOLOGY LABORATORY

8 NQF credits at HEQSF level 9

Convener: TBA

Course entry requirements: BSc (Eng) or BSc (Hons) degree or equivalent

Course outline:

This course aims to develop an understanding of basic microbiology, bioreactor technology, brewing, protein extraction and electrophoresis, DNA extraction, PCR, fluorescence microscopy, enzyme kinetics, and biotransformations.

DP requirements: None

Assessment: Assignments and practical examination.

CHE5055Z RESEARCH COMMUNICATION & METHODOLOGY

16 NQF credits at HEQSF level 9; 1 Final report..

Convener: Professor STL Harrison

Course entry requirements: BSc (Eng) or BSc (Hons) degree or equivalent

Course outline:

The aim of this course is to provide postgraduate students with the competency to execute meaningful research in a structured way, to critically analyse the results of this research and to communicate these results effectively. The course topics include: research philosophy, research planning, hypothesis development and research methodology; literature review skills; research ethics; research communication and related technical skills; experimental practice; structuring, writing and presentation of scientific outputs. The assignments include: oral presentation of seminars, scientific and technical writing tasks, experimental design tasks and literature review. The final examination comprises the compilation and presentation of the final report which is a complete research proposal.

DP requirements: Completion of all assignments and the final report (100%).

Assessment: Assignments and final report.

CHE5064Z SUSTAINABILITY IN CHEMICAL ENGINEERING

8 NQF credits at HEQSF level 9

Convener: Professor STL Harrison**Course entry requirements:** BSc (Eng) or BSc (Hons) degree or equivalent**Course outline:**

Sustainability is fast becoming a major factor in decision making in most industries employing chemical engineering graduates. Since the IChemE and its sister associations signed the London Communiqué in 1997, sustainability has become understood as a key design and operation criterion for chemical engineers to consider. This course seeks to provide graduate students with an awareness of the issues surrounding a sustainable process industry and an appreciation for its importance. The course will examine the central role of chemical engineering in achieving balance amongst economic, environmental, and social benefits and impacts for projects conducted by companies operating in the oil, chemicals, minerals and energy sectors, and will address related challenges of intensive agriculture and provision of water. It seeks to go further to provide a framework and a set of tools which will assist the process engineer in providing rational input in terms of sustainability into decision making, with quantification wherever possible.

DP requirements: None**Assessment:** Examination and assignments.

CHE5069Z ADVANCED THERMODYNAMICS AND SEPARATION

8 NQF credits at HEQSF level 9

Course entry requirements: BSc(Eng).**Course outline:**

This course aims to develop an understanding of advanced thermodynamics & separation processes. Topics include: multiphase equilibria: equations of state, activity coefficient models, gas-solid and liquid-solid systems, Gibbs free energy minimisation. Separations technology: azeotropes, residue curve/distillation curve analysis, complex separations, membranes, adsorption, reactive separations. Multi-component mass transfer: application of Maxwell-Stefan theory to separation systems.

DP requirements: None**Assessment:** Projects and assignments (50% for each project and assignment to pass course).

CHE5070Z ADVANCED BIOPROCESS ENGINEERING

16 NQF credits at HEQSF level 9

Convener: Professor STL Harrison**Course entry requirements:** BSc(Eng) or equivalent four year BSc(Hons) degree.**Course outline:**

This course is an advanced introduction to bioprocess design. Topics include: Stoichiometry of microbial growth and product formation. Mixing and oxygen transfer. Bioreactor design and scale up. Sterilisation. Material and energy balances for microbial systems. Biokinetic analysis of batch, fed-batch and continuous systems. Mixed cultures and mixed culture kinetics. Downstream processing. Bioprocess analysis. Environmental impact of bioprocesses.

DP requirements: Satisfactory completion of all projects and assignments.**Assessment:** Examination 3 hours, projects and assignments.

CHE5072Z FUNDAMENTALS OF PROCESS MODELING

4 NQF credits at HEQSF level 9

Course outline:

This advanced course covers the fundamentals of process modelling. Topics include: micro-, meso-, macro-scale modelling; population balance modelling; dynamics and stability of chemical systems.

DP requirements: Attendance 70%.**Assessment:** Project and/or examination.

CHE5078Z NUMERICAL METHODS FOR ENGINEERS

16 NQF credits at HEQSF level 9

Course entry requirements: BSc(Eng), BSc(Hons) with applied mathematics major.

Course outline:

This course in advanced numerical methods for engineers covers: computer arithmetic, linear equations (transformations, SVD), non-linear equations (quasi-newton's methods, continuation), ODEs (explicit, implicit, BDF, implicit Runge-Kutta), BVPs (collocation, finite differences, shooting method, finite elements), DAEs (index, implicit solvers), PDEs (collocation, finite differences, finite elements, iterative methods), model regression (least squares, variance, bootstrap, parameter estimation), and parametric sensitivity analysis (transient, steady state).

DP requirements: None

Assessment: Projects and assignments (50% for each project and assignment to pass course).

CHE5082Z DISSERTATION PREPARATION

DP requirement for entry to CHE5002W.

0 NQF credits at HEQSF level 9

Co-requisites: CHE5055Z

Course outline:

The aim of this course is to allow a student to undertake preparatory work for the 120 credit dissertation (CHE5002W). Work required may include ensuring that research infrastructure (e.g. apparatus etc.) is or will be in place, setting up of models, collection of data. The student should maintain regular contact with his/her supervisor in order to show evidence of suitable progress towards these aims. The supervisor must indicate satisfactory fulfilment of the course aims prior to the student proceeding to the dissertation.

DP requirements: None

CHE5083Z TRANSLATING TECHNOLOGY FROM THE LABORATORY TO THE MARKETPLACE

8 NQF credits at HEQSF level 9

Convener: Professor STL Harrison

Course entry requirements: BSc (Eng) or BSc (Hons) or equivalent

Course outline:

This course aims to develop an understanding of how to translate technology from the laboratory to the marketplace. Topics covered include technology commercialisation; intellectual property; start-up companies (structure, resourcing); entrepreneurial resources; introduction to entrepreneurial finance and funding; business models specific to biotechnology; understanding the components of a business plan; and market research.

DP requirements: Satisfactory completion of 80% assignments

Assessment: Year mark.

CHE5086Z ELECTROCHEM CHARACTERISATION TECHNIQUES FOR FUEL CELLS

4 NQF credits at HEQSF level 9; block release.

Convener: Associate Professor P Leveque

Course entry requirements: BSc (Eng) or equivalent four years BSc (Hons)

Course outline:

Basics of electrochemistry: electrode reactions, electron transfer, double layer, design of experiment. Platinum as electrocatalyst: behaviour in bulk and as nanoparticle. The role of carbon and other supports for fuel cell catalysts. Theoretical and practical aspects of cyclic voltammetry, electrochemical impedance spectroscopy, rotation disk electrode, polarisation curve, current interrupt and linear sweep voltammetry. Overview of selected physical/chemical characterisation techniques and their application in fuel cell research.

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DP requirements: None

Assessment: Coursework 30%, Examination 70%

CHE5087Z RESEARCH METHODOLOGY

16 NQF credits at HEQSF level 9; block release.

Convener: Professor STL Harrison

Course outline:

This course aims to provide postgraduate students with competency to execute meaningful research in a structured way, to critically analyse the results of this research and to communicate these results effectively. To achieve this, the course topics include research philosophy; research planning, hypothesis development and research methodology; literature review skills; research ethics; research communication and related technical skills; structuring, writing and presentation of research outputs.

Entrance is limited to students registered for the M Phil specialising in Sustainable Mineral Resource Development offered by the University of Cape Town and the equivalent Master of Mineral Science Degree in Sustainable Mineral Resources Development, offered by the University of Zambia.

DP requirements: None

Assessment: Coursework 100%.

CHE5088Z INTRODUCTION TO HETEROGENEOUS CATALYSIS RESEARCH

8 NQF credits at HEQSF level 9

Convener: Associate Professor N Fischer

Course entry requirements: BSc Honours in Science or BSc (Eng) or equivalent.

Co-requisites: None

Course outline:

This course aims to facilitate the connection between high level theory and practical application, for new MSc students in the field of heterogeneous catalysis research. Included are safety aspects specific to laboratories in the Centre for Catalysis Research, the design of test units (including material section, valve design, and temperature/pressure control), and the preparation of various types of heterogeneous catalysts.

DP requirements: Pass presentation on experimental plan for heterogeneous catalysis preparation practical (pass/fail principle, no grades).

Assessment: Written report on heterogeneous catalyst preparation practical (40%); Written exam on course including safety aspects, planning/design/operation of rigs and heterogeneous catalysis preparation (60%).

CHE5089Z CHARACTERIZATION TECHNIQUES FOR CATALYSIS RESEARCH

12 NQF credits at HEQSF level 9

Convener: Associate Professor N Fischer

Course entry requirements: BSc Honours in Science or BSc (Eng) or equivalent.

Co-requisites: None

Course outline:

This course aims to facilitate the connection between high level theory and practical application for new MSc students in the field of heterogeneous catalysis characterization techniques. It includes common techniques available in or associated with the laboratories in the Centre for Catalysis Research such as temperature programmed techniques, elemental analysis methods, electron microscopy, X-ray and light based techniques (i.e. Raman and infra-red spectroscopy), gas chromatography and the introduction of more specialized methods such as X-ray absorption, solid state NMR and surface science techniques.

DP requirements: None

Assessment: Written reports on different practicals (each 10%, total 40%); Written exam on course covering all introduced characterization techniques, both in theoretical background as well as data collection and analysis (60%).

CHE6000W PHD IN CHEMICAL ENGINEERING

360 NQF credits at HEQSF level 10

Co-requisites: CHE5055Z

Course outline:

A PhD thesis is required to be an original, coherent and consistent body of work which reflects the candidate's own efforts. The thesis may not be more than 80 000 words. A candidate will undertake research, and such advanced coursework as may be required, under the guidance of a supervisor or supervisors appointed by Senate

DP requirements: None

Assessment: Written work counts 100%.

CHE9003Z INTERNATIONAL AFFILIATE 6-12 M

0 NQF credits at HEQSF level 0

END5050X MASTERS JOURNAL PAPER REQUIREMENT

0 NQF credits at HEQSF level 9

Course outline:

The aim of submitting a research paper for the masters' degree is to develop an understanding of what is required for the publication of research findings. To this end a candidate shall submit a summary of the key aspects of the dissertation, presented in the form of a paper which is, potentially, of publishable standard, approved by a Panel of Assessors. This is a requirement for candidates submitting either a 180 or 120 credit dissertation for the following degrees: MSc in Construction Economics and Management, MSc(Eng), MSc(ProjMan), MPhil, MSc in Property Studies. Refer to the appropriate degree rules.

DP requirements: None

Assessment: Written reports on different practicals (each 10%, total 40%); Written exam on course covering all introduced characterization techniques, both in theoretical background as well as data collection and analysis (60%).

CHE6000W PHD IN CHEMICAL ENGINEERING

360 NQF credits at HEQSF level 10

Co-requisites: CHE5055Z

Course outline:

A PhD thesis is required to be an original, coherent and consistent body of work which reflects the candidate's own efforts. The thesis may not be more than 80 000 words. A candidate will undertake research, and such advanced coursework as may be required, under the guidance of a supervisor or supervisors appointed by Senate

DP requirements: None

Assessment: Written work counts 100%.

CHE9003Z INTERNATIONAL AFFILIATE 6-12 M

0 NQF credits at HEQSF level 0

END5050X MASTERS JOURNAL PAPER REQUIREMENT

0 NQF credits at HEQSF level 9

Course outline:

The aim of submitting a research paper for the masters' degree is to develop an understanding of what is required for the publication of research findings. To this end a candidate shall submit a summary of the key aspects of the dissertation, presented in the form of a paper which is, potentially, of publishable standard, approved by a Panel of Assessors. This is a requirement for candidates submitting either a 180 or 120 credit dissertation for the following degrees: MSc in Construction Economics and Management, MSc(Eng), MSc(ProjMan), MPhil, MSc in Property Studies. Refer to the appropriate degree rules.

DP requirements: None