

## BQA NCQF QUALIFICATION TEMPLATE

<b>SECTION A: QUALIFICATION DETAILS</b>													
<b>QUALIFICATION DEVELOPER (S)</b>	Botswana International University of Science & Technology												
<b>TITLE</b>	Doctor of Philosophy Chemical Engineering						<b>NCQF LEVEL</b>		10				
<b>FIELD</b>	Manufacturing Engineering and Technology						<b>CREDIT VALUE</b>		360				
<b>SUB FIELD</b>	Engineering and Engineering Trades												
New Qualification		√		Legacy Qualification				Renewal Qualification					
								Registration Code					
<b>SUB-FRAMEWORK</b>		General Education				TVET				Higher Education			
<b>QUALIFICATION TYPE</b>		Certificate	I	II	III	IV	V	Diploma		Bachelor			
		Bachelor Honours			Post Graduate Certificate				Post Graduate Diploma				
		Masters				Doctorate/ PhD				√			
<b>RATIONALE AND PURPOSE OF THE QUALIFICATION</b>													
<p><b>RATIONALE:</b></p> <p>The Doctor of Philosophy degree (PhD) in Chemical Engineering is designed to produce graduates with an extended specialist knowledge in a particular area of Chemical Engineering, crucial for solving complex engineering challenges through collaboration with industry, particularly those that are specific to Botswana’s natural resources, industries, water scarcity, waste management and environmental concerns, and is currently the only such programme in Botswana. The PhD in Chemical Engineering degree enhances local expertise and innovation, and contributes to the growth of research and development (R&amp;D), which is essential for the technological and economic advancement of Botswana, as this can lead to the development of new processes, products, and materials. The qualification also supports Botswana’s economy diversification efforts from the mining sector, towards manufacturing, renewable energy and agriculture sectors. Above all, the PhD in Chemical Engineering degree creates a local pool of PhD trained chemical engineers to help build human capacity and reduce reliance on foreign expertise, as well as promoting Botswana’s global competitiveness. The following key national documents and policies of Botswana demonstrate a clear need for highly trained PhD level experts/professionals in Chemical Engineering, to drive forward the country’s economic diversification, technological innovation, and sustainable development: a) National Development Plan (with sections focusing on; i. Economic Diversification, ii. Sustainable Development Goals, iii. Science, technology and Innovation), b) Botswana Vision 2036 (with sections focusing on; i. Human Capital Development, ii. Economic Transformation and Innovation), c) The Education and Training Sector</p>													

Strategic Plan (with sections focusing on; i. Advanced Education and Research, ii. Capacity Building in Critical Areas), d) The Botswana Innovation Hub Strategic Plan (with sections focusing on; i. Technology Transfer and Commercialisation, ii. Research and Development), e) Botswana's Science, Technology, and Innovation Policy (with sections focusing on; i. Industrial Innovation, ii. Environmental Stability) and f) The Botswana National Science and Technology Research Policy (with sections focusing on; i. Energy and Environment, ii. Industrial Process and Manufacturing). The National Human Resources Development Plan 2028 highlighted that one of the challenges in transition towards a knowledge-based economy in Botswana is the lack of graduates with high level critical thinking skills that generally provide for high order thinking, including problem solving. The report also highlighted the need for graduates that are capable of learning and applying knowledge through creative thinking and critical analysis. Such requirements can only be achieved through producing graduates with higher level skills, capable of not only evaluating but of critical analysis, which is addressed at postgraduate level. Based on several studies, it has been found that graduate programmes contribute to the development of talent-rich ecosystems that drive global competitiveness and economic growth [10.18178/ijiet.2022.12.11.1741](https://doi.org/10.18178/ijiet.2022.12.11.1741)

This aligns with the University's mission by addressing critical challenges essential for the sustainable development of Botswana. The program ensures that graduates are equipped to advanced knowledge, drive technological advancements, and support sustainable practices that align with the University's vision for a sustainable future. The PhD in Chemical Engineering degree also qualifies as meeting the academic requirements for professional registration with the Engineering Registration Board (ERB) in Botswana, however, the applicant must also demonstrate sufficient practical experience and competency in the application of engineering principles in real-world scenarios. Thus, a PhD in Chemical Engineering degree holder should document any industrial or applied engineering work undertaken during the PhD (e.g., collaborations with companies, industrial projects, internships) and also, gain professional experience under the supervision of a registered engineer if their academic work was primarily theoretical.

### **PURPOSE: (itemise exit level outcomes)**

The purpose of this qualification is to produce graduates with most advanced knowledge, skills, and competence:

- Analyse research data for solving complex Chemical engineering problems in academia, research and development and industry through experimentation, modelling and simulation.
- Evaluate and synthesize advanced knowledge in academia, research and development, and industry for the development of processes and products.
- Innovate and lead in industry, research and development, academia, mining and beneficiation, sustainable energy, water scarcity and waste management by designing and executing original research, solving complex problems, and contributing to the advancement of the discipline through strategic applications of their expertise.
- Design and develop products and processes through advanced research and contribute innovative solutions in the fields of energy, water, mining and natural resources beneficiation, and process engineering.

### **MINIMUM ENTRY REQUIREMENTS (including access and inclusion)**



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- A Master of Engineering Degree in Chemical Engineering or related discipline (NCQF level 9) from a recognised University.
- RPL and CAT may be considered for admission in the qualification according to the university RPL and CAT policies.

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SECTION B QUALIFICATION SPECIFICATION	
GRADUATE PROFILE (LEARNING OUTCOMES)	ASSESSMENT CRITERIA Graduate should be able to:
<p>1. Produce original research contribution(s) to academia and/or industry in the discipline of Chemical Engineering and/or other closely related disciplines. Original research here encompasses various areas from sustainable energy, environmental remediation, advances in materials design, food processing, process systems engineering among other chemical engineering areas.</p>	<p>1.1 Design and implement an independent piece of scientific research.</p> <p>1.2 Acquire new knowledge in Chemical Engineering and/or other closely related</p> <p>1.3 Develop advances in disciplinary knowledge in the field of Chemical Engineering and other closely related disciplines.</p> <p>1.4 Adhere to the International Engineering Alliance engineering standards through ensuring consistent designs, quality with adequate reliability and well-defined configurations.</p>
<p>2. Create innovative solutions that address complex scientific and engineering problems in research, development, design or production sectors related to Chemical Engineering and/or other closely related disciplines.</p>	<p>2.1 Diagnose complex technical problems in research, product development, design or production sectors.</p> <p>2.2 Outline possible solutions by taking into consideration technical, socio-economic and environmental aspects.</p> <p>2.3 Produce innovative solutions to complex scientific and engineering problems.</p>
<p>3. Provide experimental methodology training (relevant to their research speciality work) and some equipment training to junior researchers (after the graduate has had sufficient equipment training from laboratory technicians) to enable them to become independent researchers.</p>	<p>3.1 Show an in-depth understanding of knowledge in the discipline for effective skills transfer.</p> <p>3.2 Demonstrate the ability to instruct and guide junior researchers in the proper use of some laboratory equipment and tools, as well as in the methodologies they have developed and applied through their own research training.</p>

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	<p>3.3 Demonstrate familiarity with the development of experimental methodology.</p>
<p>4. Demonstrate professional and ethical conduct in all aspects of research and academic practice. Should be able to take responsibility for research decisions and exercise sound judgment based on advanced knowledge acquired and technical expertise gained during the PhD.</p>	<p>4.1 Apply professional and ethical codes of conduct in the execution of scientific and engineering related work.            4.2 Assume full responsibility of tasks executed in the exercise of one's profession and those delegated to subordinates.            4.3 Make expert decisions and recommendations within one's field of practice.</p>
<p>5. Lead scientific research projects within the budgetary and time constraints</p>	<p>5.1 Formulate and design a comprehensive scientific research project.            5.2 Integrate multidisciplinary expertise, including management, economics, and environmental considerations, into the execution of complex scientific projects.            5.3 Lead and guide a team in advancing a specialised scientific or engineering project.</p>
	

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<b>SECTION C</b>	<b>QUALIFICATION STRUCTURE</b>
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## BQA NCQF QUALIFICATION TEMPLATE

COMPONENT	TITLE	Credits Per Relevant NCQF Level			Total Credits
		Level [ ]	Level [ ]	Level [ ]	
<b>FUNDAMENTAL COMPONENT</b>  Subjects/ Courses/ Modules/Units					
<b>CORE COMPONENT</b>  Subjects/Courses/ Modules/Units	<i><b>PhD Chemical Engineering Thesis</b></i>			<b>360</b>	<b>360</b>
<b>STRANDS/ SPECIALIZATION</b>	Subjects/ Courses/ Modules/Units	Credits Per Relevant NCQF Level			Total Credits
		Level [ ]	Level [ ]	Level [ ]	

## BQA NCQF QUALIFICATION TEMPLATE

<b>1.</b>				
<b>2.</b>				
<b>Electives</b>				

SUMMARY OF CREDIT DISTRIBUTION FOR EACH COMPONENT PER NCQF LEVEL	
TOTAL CREDITS PER NCQF LEVEL	
NCQF Level	Credit Value
<b>10</b>	<b>360</b>
<b>TOTAL CREDITS</b>	<b>360</b>
<b>Rules of Combination:</b> (Please Indicate combinations for the different constituent components of the qualification)	

The qualification is research based and has no course work component. The PhD learner must attain all 360 credits and meet the viva voce defence.

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### ASSESSMENT ARRANGEMENTS

- For the PhD learner to be awarded the degree, they ought to have published three (3) journal papers, submission of an original thesis, and successfully defend the thesis through an oral viva voce, which is 100% summative.

### MODERATION ARRANGEMENTS

- Moderation is done by a panel of the examining committee through an oral defence (viva voce).
- The PhD thesis shall be examined by internal and external examiners.
- A supervisor shall not be appointed as an examiner.
- These are all in accordance with the university Postgraduate Guidelines/Policy.

### RECOGNITION OF PRIOR LEARNING

RPL will be considered for the award of this qualification according to the RPL policies. The PhD learner also must meet the viva voce defence as set, where some credits were attained by RPL.

### CREDIT ACCUMULATION AND TRANSFER

CAT will be considered for the award of this qualification according to the CAT policies. The PhD learner also has to meet the viva voce defence as set, where some credits were attained by CAT.

### PROGRESSION PATHWAYS (LEARNING AND EMPLOYMENT)

#### Vertical Pathway

Possible vertical articulations:

- direct admission to the post-doctoral programme in Chemical Engineering

#### Horizontal Pathway

- PhD qualifications in science, engineering or engineering management.
- Engineering Doctorate (EngD) qualifications in; i. Process Engineering, ii. Environmental Engineering etc...
- Doctor of Science (DSci) qualifications in; i. Waste Valorisation, ii. Water Science etc...
- direct admission to the Doctor of Technology (DTech) qualifications in; i. Process Control Simulations etc...

#### Employment Pathway

Possible employment articulations:

- Public or private researcher
- Chemical engineer
- Process engineer

- Safety, health, environmental and quality (SHEQ) engineer
- Research and development (R&D) engineer
- Design engineer
- Environmental process engineer
- Product and development engineer
- Product engineer
- Project manager

in a number of industries such as chemical and petrochemical, food processing, mineral processing, bioprocessing, pharmaceuticals, textiles and personal care product industries.

### QUALIFICATION AWARD AND CERTIFICATION

#### **Qualification to be Awarded**

For one to be awarded a PhD in Chemical Engineering degree, they must have achieved 360 credits

#### **Credits to be Awarded**

360 Credits

#### **Certification**

Candidates meeting prescribed requirements and attaining 360 credits will be awarded the certificate in accordance with standards prescribed for the award of the qualification and applicable policies.

### SUMMARY OF REGIONAL AND INTERNATIONAL COMPARABILITY

#### **Similarities Observed:**

Title of Qualification, NQF Level & Credit Value or Duration (where applicable)

- All three institutions offer a Doctor of Philosophy (PhD) in Chemical Engineering.
- All are at the highest academic level (Level 10 for UCT and UQ, FHEQ Level 8 for UoB, which corresponds to doctoral qualifications in the UK).
- The programs are research-based, with a duration of 3-4 years at UQ and UoB, and a minimum of 2 years at UCT. Credit values vary but are equivalent in terms of research workload (360 credits for UCT and UQ, 540 credits for UoB).

#### Main Exit Outcome(s)

- All programs emphasize original research, critical thinking, the ability to make substantial contributions to knowledge, and effective communication in both written and oral forms.
- Graduates are expected to engage in advanced problem-solving, make informed decisions in complex situations, and demonstrate independence in research.

Domains/Modules/Courses/Subjects covered (Fundamental, core & electives)

- All institutions focus on fundamental, core, and elective modules, though the University of Birmingham offers both research-based and integrated study models, combining research with taught elements.
- Learners engage in independent research, with training in relevant methodologies, and are expected to contribute original ideas to the field.

### Assessment strategies and Weightings

- Assessment methods include written examinations (typically thesis submission), and oral examinations (e.g., viva voce), as well as progress reports and research proposals.
- All institutions assess research quality through the thesis as a key requirement, with additional progress assessments or oral defences.

### Qualification rules and minimum Standards for the award of the qualification

- To be awarded the PhD, candidates must produce original work that significantly contributes to knowledge in their field.
- There are specific requirements to ensure the work is original (no prior submissions for other degrees) and made in the candidate's own words and findings.

### **Differences Observed:**

#### Title of Qualification, NQF Level & Credit Value or Duration (where applicable)

- UCT and UQ both offer a straightforward research-focused PhD, while UoB offers multiple types, including a PhD with integrated study (4 years) and a Doctor of Engineering (EngD), which includes taught elements along with research.

#### Main Exit Outcome(s)

- While all institutions expect candidates to make an original contribution to their field, UQ specifically emphasizes professional skills applicable to both academic and professional careers. UoB places a greater emphasis on both academic research and professional practice, particularly for its integrated study and professional doctorate tracks.

#### Domains/Modules/Courses/Subjects covered (Fundamental, core & electives)

- UoB uniquely offers both research-only PhD and PhDs with integrated taught study, which is not available at UCT and UQ. The integrated study approach at UoB includes up to 180 credits of taught postgraduate work, combining research with taught modules.

### Assessment strategies and Weightings

- The assessment at UQ does not include an oral examination, focusing solely on thesis submission. In contrast, UCT and UoB both require an oral thesis defense (viva voce) as part of the assessment process, with UCT also using progress reports and written proposals during the research period.

### Qualification rules and minimum Standards for the award of the qualification

- While all institutions expect original, high-quality research, UQ has a specific requirement for the thesis to be no more than 80,000 words, a detail not specified in the other institutions.

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- UoB also includes additional provisions for the PhD with Integrated Study, which includes both taught components and research, unlike UCT and UQ's purely research-focused models.

In summation and comparatively, the qualification is on par with the counterpart qualifications at UCT and UoB given the similarity in the entry requirements and the output required. However, the PhD in Chemical Engineering qualification described here is more robust than the UQ one in that, at UQ, only the thesis is assessed without an oral examination.

### REVIEW PERIOD

The review period for this qualification is 5 years.

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#### For Official Use Only:

<b>CODE (ID)</b>			
<b>REGISTRATION STATUS</b>	<b>BQA DECISION NO.</b>	<b>REGISTRATION START DATE</b>	<b>REGISTRATION END DATE</b>
<b>LAST DATE FOR ENROLMENT</b>		<b>LAST DATE FOR ACHIEVEMENT</b>	