BQA NCQF QUALIFICATION TEMPLATE

SECTION A:	QUALIFICATION DETAILS																
QUALIFICATION DEVELOPER (S)	Botswana International University of Science & Technology																
TITLE	Doctor Of Philosophy Materials and Metallurgical Engineering													**NCQF LEVEL**	*10*		
FIELD	Manufacturing Engineering and Technology													**CREDIT VALUE**	*360*		
SUB FIELD	Engineering and Engineering Trades																
New Qualification	√	Legacy Qualification										Renewal Qualification					
												Registration Code					
SUB-FRAMEWORK	General Education						TVET					Higher Education	√				
QUALIFICATION TYPE	Certificate	I		II		III		IV		V		Diploma		Bachelor			
	Bachelor Honours					Post Graduate Certificate						Post Graduate Diploma					
	Masters							Doctorate/ PhD	√								

RATIONALE AND PURPOSE OF THE QUALIFICATION

RATIONALE:

The Doctor of Philosophy (PhD) in Materials & Metallurgical Engineering is designed to develop graduates with specialized expertise in key areas of the field, critical for addressing complex engineering challenges. The program emphasizes collaboration with industry, particularly in areas pertinent to Botswana's natural resources, water scarcity, waste management, and environmental concerns. It is the only PhD program of its kind in Botswana.

The PhD enhances local expertise and fosters innovation, contributing to the growth of research and development (R&D) essential for Botswana's technological and economic progress. This qualification is pivotal in advancing new processes, products, and materials, and supports Botswana's efforts to diversify its economy from mining toward manufacturing, renewable energy, and agriculture. Moreover, the program creates a local pool of highly trained Materials & Metallurgical engineers, reducing reliance on foreign expertise and boosting Botswana's global competitiveness.

Several national documents and policies underline the need for PhD-level experts in Materials & Metallurgical Engineering to drive Botswana's economic diversification, technological innovation, and sustainable development. These include:

i. **National Development Plan**, which focuses on economic diversification, sustainable development goals, and science, technology, and innovation.

ii. **Botswana Vision 2036**, with sections on human capital development, economic transformation, and innovation.

iii. **Education and Training Sector Strategic Plan**, emphasizing advanced education, research, and capacity building.

iv. **Botswana Innovation Hub Strategic Plan**, which highlights technology transfer, commercialization, and R&D.

v. **Botswana's Science, Technology, and Innovation Policy**, focusing on industrial innovation and environmental stability.

vi. **Botswana National Science and Technology Research Policy**, addressing energy, environment, and industrial manufacturing processes.

The **National Human Resources Development Plan (NHRDP) 2028** also highlights the challenge of transitioning to a knowledge-based economy in Botswana due to the shortage of graduates with advanced critical thinking and problem-solving skills. To meet this demand, higher-level education and critical analysis capabilities, such as those developed at the postgraduate level, are essential. Studies have shown that graduate programs contribute to the creation of talent-rich ecosystems that drive global competitiveness and economic growth (10.18178/ijiet.2022.12.11.1741).

This PhD program directly aligns with the University's mission to address the key challenges essential for Botswana's sustainable development. Graduates will be equipped with advanced knowledge, the ability to drive technological innovations, and the capacity to support sustainable practices, all of which are in line with the University's vision for a sustainable future.

Additionally, the PhD in Materials & Metallurgical Engineering meets the academic requirements for professional registration with Botswana's Engineering Registration Board (ERB). However, candidates must also demonstrate practical experience and competency in applying engineering principles in real-world settings. Applicants are encouraged to document any industrial collaborations, projects, or internships completed during their PhD and to gain professional experience under the supervision of a registered engineer if their academic work was largely theoretical.

PURPOSE: (itemise exit level outcomes)

The purpose of the qualification is to produce graduates with specialized knowledge, skills, and competence to:

- Analyse research data to address complex Materials & Metallurgical Engineering challenges in academia, research, development, and industry, utilizing techniques such as experimentation, modelling, and simulation.
- Evaluate and integrate advanced knowledge across academia, research, development, and industry to support the creation of innovative processes and products.
- Innovate and lead in industry, research and development, academia, mining and beneficiation, sustainable energy, water scarcity, and waste management by conducting original research, solving intricate problems, and advancing the field through strategic applications of expertise.

• Design and develop novel products and processes through advanced research, offering innovative solutions in energy, water management, mining and natural resources beneficiation, and process engineering.
MINIMUM ENTRY REQUIREMENTS (including access and inclusion)
• A Master of Engineering Degree in Materials & Metallurgical 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:**
1. Produce original research contribution(s) to academia and/or industry in the discipline of Materials & Metallurgical 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 Materials and Metallurgical Engineering areas.	1.1 Design and implement an independent piece of scientific research. 1.2 Acquire new knowledge in Materials & Metallurgical Engineering and/or other closely related fields. 1.3 Develop advances in disciplinary knowledge in the field of Materials & Metallurgical Engineering and other closely related disciplines. 1.4 Adhere to the International Engineering Alliance engineering standards through ensuring consistent designs, quality with adequate reliability and well-defined configurations.
2. Create innovative solutions that address complex scientific and engineering problems in research, development, design or production sectors related to Materials & Metallurgical Engineering and/or other closely related disciplines.	2.1 Diagnose complex technical problems in the research, development, design or production sectors. 2.2 Outline possible solutions by taking into consideration technical, socio-economic and environmental aspects. 2.3 Produce innovative solutions to complex scientific and engineering problems.

3. Provide experimental methodology training (relevant to their research speciality work) and some equipment training to junior researchers (after the graduate student has had sufficient equipment training from laboratory technicians) to enable them to become independent researchers.	3.1 Show an in-depth understanding of knowledge in the discipline for effective skills transfer. 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. 3.3 Demonstrate familiarity with the development of experimental methodology.
4. Demonstrate professional and ethical conduct in all aspects of research and academic practice, taking responsibility for research decisions and exercising sound judgment based on advanced knowledge, technical expertise, and critical analysis.	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.
5. Lead scientific research projects within the budgetary and time constraints	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.

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SECTION C	QUALIFICATION STRUCTURE				
COMPONENT	TITLE	Credits Per Relevant NCQF Level			Total Credits
		Level [ ]	Level [ ]	Level [ ]	
FUNDAMENTAL COMPONENT Subjects/ Courses/ Modules/Units					
CORE COMPONENT Subjects/Courses/ Modules/Units	***PhD Materials & Metallurgical Engineering Thesis***			***360***	***360***

STRANDS/ SPECIALIZATION	Subjects/ Courses/ Modules/Units	Credits Per Relevant NCQF Level			Total Credits
		Level [ ]	Level [ ]	Level [ ]	
1.					
2.					
Electives					

SUMMARY OF CREDIT DISTRIBUTION FOR EACH COMPONENT PER NCQF LEVEL	
TOTAL CREDITS PER NCQF LEVEL	
NCQF Level	Credit Value
10	*360*

TOTAL CREDITS	***360***
Rules of Combination: **(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 student 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 Materials & Metallurgical Engineering

Horizontal Pathway

- PhD qualifications in; i. Materials Engineering, ii. Metallurgical Engineering, iii. Extractive Metallurgy, iv. Nanomaterials and Nanotechnology, v. Computational Materials Science etc…
- Engineering Doctorate (EngD) qualifications in; i. Micro and Nanomaterials and Technologies, ii. Engineering Materials, iii. Advanced Materials and Nanotechnology, iv. Inorganic Materials for Advanced Manufacturing (IMAT), v. Formulation Engineering: formulation for net zero etc…
- Doctor of Science (DSci) qualifications in; i. Chemical and Process Engineering, ii. Polymer Technology, iii. Materials Chemistry etc…
- Doctor of Philosophy (DPhil) qualifications in; i. Energy Storage Materials, ii. Structural and Nuclear Materials, iii. Nanomaterials, iv. Computational Materials Modelling, v. Processing and Manufacturing; including Metals, Alloys, Superconductors and Polymers etc…

Employment Pathway

- Public or private researcher – Specialist.
- Materials and Metallurgical engineer – Specialist.

- Process engineer – Specialist.
- Safety, health, environmental and quality (SHEQ) engineer – Specialist.
- Research and development (R&D) engineer – Specialist.
- Design engineer – Specialist.
- Project manager – Specialist.
- Foundry metallurgist – Specialist.
- Physical metallurgist – Specialist.
- Extractive metallurgist – Specialist.
- Welding engineer – Specialist.
- Metallurgical and quality control supervisor/superintendent
- Metallurgical inspector analyst – Specialist.
- Materials Engineer – Specialist.
- Process Control Engineer – Specialist.
- Metallurgical Plant Design Engineer – Specialist.
- Corrosion Engineer – Specialist.
- Foundry Engineer – Specialist.
- Heat Treatment Engineer – Specialist.
- Failure Analysis Consultant
- Tribologist – Specialist.
- Materials Consultants – Specialist.
- Mineral processing engineer – Specialist.

In a number of industries such as Materials synthesis, Metallurgical, and Corrosion protection, Materials processing, mineral processing, mining industries, consultants, etc.

QUALIFICATION AWARD AND CERTIFICATION

Qualification to be Awarded
PhD in Materials & Metallurgical Engineering degree

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 universities offer a Doctor of Philosophy (PhD) in Materials and Metallurgical Engineering.
- Each program is at the highest academic level: Level 10 for UCT and UQ, and FHEQ Level 8 for UoB (equivalent to doctoral qualifications in the UK).
- The programs are primarily research-based, with UQ and UoB lasting 3-4 years and UCT requiring a minimum of 2 years. The credit values differ: UCT and UQ both award 360 credits, while UoB grants 540 credits.

Main Exit Outcome(s)

- All programs prioritize **original research**, **critical thinking**, **significant contributions to knowledge**, and the ability to **communicate effectively** in both written and oral forms.
- Graduates are expected to demonstrate **independent research**, engage in **advanced problem-solving**, and make **informed decisions** in complex scenarios.

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

- All three institutions focus on **core, fundamental, and elective modules**. However, **UoB** offers both a **research-only PhD** and a **PhD with integrated study**, which blends research with taught modules.
- Students at all institutions undertake **independent research** and gain training in relevant **research methodologies**, with expectations of contributing **original ideas** to the field.

Assessment strategies and Weightings

- Common assessment methods include **written examinations** (usually in the form of the **thesis submission**), **oral examinations** (e.g., **viva voce**), **progress reports**, and **research proposals**.
- All three institutions emphasize the **thesis** as the primary measure of research quality, supplemented by additional assessments such as **oral defenses** or **progress updates**.

Qualification rules and minimum Standards for the award of the qualification

- To be awarded a PhD, candidates must produce **original work** that significantly contributes to their field of study.
- Strict guidelines are in place to ensure that all work is **original** and **authored by the candidate**, with no prior submissions accepted for another degree.

Differences Observed:

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

UCT and **UQ** offer a straightforward, **research-focused PhD**, while **UoB** provides several options, including a **PhD with integrated study** (lasting 4 years) and a **Doctor of Engineering (EngD)**, both of which combine research with taught components.

Main Exit Outcome(s)

- While all institutions expect candidates to make **original contributions** to their field, **UQ** places a specific emphasis on **professional skills** that are relevant in both **academic** and **industry** contexts.
- **UoB** places greater importance on both **academic research** and **professional practice**, particularly for students enrolled in the **integrated study** or **professional doctorate** tracks.

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

- **UoB** offers a unique combination of both **research-only PhDs** and **PhDs with integrated study**. The **integrated study model** includes up to **180 credits of taught postgraduate courses**, something not available at **UCT** and **UQ**.

Assessment strategies and Weightings

- **UQ** does not require an **oral examination**, relying solely on the **thesis submission** for assessment.
- In contrast, both **UCT** and **UoB** require an **oral thesis defense** (viva voce), with **UCT** also incorporating **progress reports** and **written proposals** during the research period.

Qualification rules and minimum Standards for the award of the qualification

- While all institutions demand **original, high-quality research**, **UQ** has a specific requirement for the thesis to be no longer than **80,000 words**, a detail not specified by the other universities.

UoB includes additional provisions for the **PhD with Integrated Study**, which combines taught coursework and research, unlike the **research-focused PhDs** offered by **UCT** and **UQ**.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. The PhD at UoB is more complete though as it has taught elements to the course giving graduates a slight edge in industry. However, this PhD in Materials and Metallurgical Engineering qualification 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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CODE (ID)			
REGISTRATION STATUS	**BQA DECISION NO.**	**REGISTRATION START DATE**	**REGISTRATION END DATE**
LAST DATE FOR ENROLMENT		**LAST DATE FOR ACHIEVEMENT**	