BQA NCQF QUALIFICATION TEMPLATE

SECTION A:	QUALIFICATION DETAILS																			
QUALIFICATION DEVELOPER (S)	Botswana International University of Science and Technology																			
TITLE	Doctor of Philosophy in Electronics Engineering																**NCQF LEVEL**	10		
STRANDS (where applicable)	1. Electronics Engineering 2. VLSI Engineering 3. Embedded Systems 4. Applied Electronics																			
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:

According to the Global Innovation Index, Botswana is ranked 89th out of 131 countries and is classified as one of the top five economies in Sub-Saharan Africa[1]. In recognition of the country's poor performance globally, the Government of Botswana has taken proactive steps for developing human capacity and infrastructure to drive sustainable economic diversification that leverages on research, science, technology, and innovation[2,3,4]. Vision 2036 advocates for sustainable economic

development, together with human and social development, which requires Batswana to attain the necessary skills and competencies to advance their country[5]. National Development Plan (NDP) 11 Goal states the need to provide an adequate supply of qualified, productive, and competitive human resources policy frameworks[6]. The Human Resource Development Council (HRDC) of Botswana has recognised 'Engineering and Technology' as one of the fields that are right now encountering deficiencies in the labour market (short term) and occupations that show moderately solid business development (long term) (HRDC, 2024)[6].

To this end, a Doctor of Philosophy (Ph.D.) in Electronics Engineering qualification is necessary. This is one of the vital engineering qualifications, particularly in developing countries like Botswana7,8. It provides a strong theoretical foundation, practical skills, professional conduct, and critical thinking in Electronics Engineering[9,10].

The PhD Electronics Engineering qualification is developed to contribute to human capital development and to fulfil the demand gap as per the HRDC 2019 report. It is against this background that this qualification has been developed to address the urgent need for adequately trained manpower to manage the area of Electronics Engineering in various sectors of the economy (HRDC 2024, Vision 2036, and National Development Plan 11). This qualification helps to build the human capital in the areas given below for the HRDC – Priority Skills and Employment Trends:

- Designing advanced electronics systems and control circuits.
- Designing advanced electronics devices and their application to industries.
- Designing advanced components, devices and systems to meet the industry needs.
- Developed and wrote software and firmware for microcontrollers and filed qualification controllers for industrial control applications.

Aims

Creativity and scientific knowledge are combined in electronics engineers to create new ideas and innovations that can work with technology, electronics, and system design. Students will have different options in the specialization, such as working with advanced electronics circuits, embedded system design, VLSI, MEMS, power electronics and applied electronics. Electronics engineering advanced with the latest changes in electronics. Electronics have become increasingly interdependent due to advances in sensors, advanced semiconductor devices, advanced digital system design, VLSI technologies, medical instruments, and embedded systems that enable more cost-effective electronic systems. The complexity of the utility industry has given rise to complexity in the control using

electronics. This has, in turn, given rise to the need for infrastructure to support varying operational and security requirements. Utilities are increasingly adopting data analytics in their operational systems to drive efficiency, reliability, and more informed decisions. These analytics are enabled by the data-rich environments that the increasingly intelligent devices and sensors provide. This further emphasises the dependence on advanced electronics for the control that provides these connections to the utility operational systems. It is in this view that the discipline of Electronics Engineering is important to form the Doctor of Philosophy (PhD) in Electronics Engineering Qualification.

The qualification allows the students to cover all the basics of electronics, advanced digital system design, very large-scale integrated systems, embedded systems, the Internet of Things, medical instruments, and wireless sensor networks. The qualified Ph.D. Electronics Engineers will be ready to take up employment, conduct research and innovation in the electronics industry on medical electronics, very large-scale integrations, embedded systems, digital system design, and machine control using advanced power electronics to develop the economy and the scientific knowledge pool in Botswana and in the world[11].

PURPOSE: (itemise exit level outcomes)

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

1. Apply knowledge and demonstrate a comprehensive understanding of electronics engineering principles to solve complex problems within the discipline.
2. Design complete and complex systems in advanced electronics circuits, embedded system design, VLSI, MEMS, power electronics and applied electronics from the simulation steps to the final realisation and able to propose innovative solutions to improve existing systems.
3. Demonstrate proficiency in comprehending and adapting to multidisciplinary projects and environments, utilising advanced knowledge to contribute effectively and achieve success in electronics engineering
4. Execute engineering projects and proficiently develop products by applying engineering principles independently with minimum supervision using problem-solving skills and innovative techniques for advanced electronics engineering.
5. Communicate ideas, information and opinions using appropriate verbal, written, and non-verbal means across various contexts and audiences.

MINIMUM ENTRY REQUIREMENTS (including access and inclusion)

Entry Requirements

Minimum entry qualification

i) NCQF level 9 or equivalent in the same field.
ii) Credit Accumulation and Transfer (CAT) and Recognition of Prior Learning (RPL) can be considered for entry according to National CAT and RPL policies.

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SECTION B	QUALIFICATION SPECIFICATION
GRADUATE PROFILE (LEARNING OUTCOMES)	**ASSESSMENT CRITERIA**
1. Synthesize and apply advanced principles of advanced electronics circuits, embedded system design, VLSI, MEMS, power electronics and applied electronics to model, analyse, and address complex electronics engineering problems, contributing innovative solutions and new knowledge to the field.	1.1 Model and simulate advanced electronic circuits and systems using appropriate tools and techniques. 1.2 Identifies and analyses complex engineering problems within circuits, embedded systems, and power electronics, applying theoretical knowledge to assess potential solutions. 1.3 Synthesise components from various domains (e.g., VLSI, MEMS) into cohesive systems to address multifaceted engineering challenges. 1.4 Create functional, reliable prototypes showing proficiency in embedded system design by integrating hardware and software components 1.5 Generate innovative solutions by critically evaluating and incorporating new methods, tools, and technologies in circuit and system design. 1.6 Apply creative problem-solving techniques to improve existing designs and develop novel solutions that advance knowledge in the field.

	Documents and communicates findings effectively, contributing to scholarly literature or industry standards.
2. Evaluate and synthesise scientific information to inform research decisions, methodology development, and innovation in electronics engineering.	2.1 review and critically assess scientific literature and recent advancements in electronics engineering. 2.2 Identify credible sources, trends, and gaps in research to support informed decision-making in research projects. 2.3 Synthesise information from various scientific and engineering disciplines to comprehensively understand complex electronics challenges. 2.4 Apply interdisciplinary insights to refine research objectives, adapt methodologies, and foster innovation in engineering solutions. 2.5 Develop research methodologies based on evaluated scientific evidence, ensuring alignment with best practices and industry standards. 2.6 Design innovative solutions, prototypes, or systems that advance electronics engineering. 2.7 Communicate findings and methodological innovations effectively through reports, publications, or presentations, contributing to the field's body of knowledge.
3. Design and implement of advanced engineering solutions grounded in electronics research findings by exhibiting profound	3.1 Evaluate the application of practical skills and competencies in electronics engineering through the design and implementation of advanced engineering solutions.

practical skills and competencies in electronics applications	3.2 Assess through practical projects, system simulations, and the development of prototypes or software, demonstrating the application of research findings to real-world problems. 3.3 Capacity of students to combine the theoretical tools and the law controlling advanced electronics engineering to analyse critical quantities in electronics systems.
4. Communicate complex scientific and engineering concepts effectively in written, oral, and visual forms, catering to both professional audiences and the wider community, ensuring clarity, coherence, and technical accuracy.	4.1 Assess the ability to communicate complex engineering concepts and research findings effectively, in written, oral, and visual forms, to both technical and non-technical audiences. 4.2 Evaluate through presentations, technical reports, research publications, and visual aids that demonstrate clarity, coherence, and technical accuracy. 4.3 Appropriate referencing conventions are used, plagiarism is avoided, and intellectual property is respected.
5. Conduct rigorous engineering design and research projects that employ investigative research, analytical methodologies, and innovative problem-solving techniques to address real-world challenges in electronics engineering.	5.1 Evaluate the ability to conduct rigorous engineering design and research projects that utilize investigative research and analytical methodologies to solve engineering problems. 5.2 Assess through design documentation, research project reports, and the presentation of innovative solutions addressing real-world challenges in electronics engineering. 5.3 Use research-based knowledge and research methods including prediction and modelling to

	complex electronics engineering activities with an understanding of the limitations.
6. Evaluate and integrate considerations of ethical, societal, and environmental impacts in engineering projects and solutions, demonstrating a commitment to sustainable and responsible engineering practices.	6.1 Assess the ability to consider and integrate ethical, societal, and environmental considerations in engineering projects and solutions. 6.2 Evaluate through case studies, project reports, and ethical analyses that demonstrate a commitment to sustainable and responsible engineering practices, including the impact of engineering solutions on society and the environment. 6.3 Appy reasoning informed by the contextual knowledge to access societal, health, safety, legal and cultural issues, and the consequent responsibilities relevant to the professional engineering practice.

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	Thesis of Doctor of Philosophy Degree in Electronics Engineering			10	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***
Level 10	360
TOTAL CREDITS	**360**

Rules of Combination:
(Please Indicate combinations for the different constituent components of the qualification)

To graduate with the 3-year Doctor of Philosophy (PhD) degree Qualification in **Electronics**, students must have successfully completed a minimum of 360 Credit Units. The Doctor of Philosophy (Ph.D) qualification in Electronics Engineering offers an integrated approach of these skills by project-based learning and subject-specific courses. Electronics-based projects are part of the research. The total study Qualification of 3 years is full-time research.

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ASSESSMENT ARRANGEMENTS

- **Formative Assessment**: 0
- **Summative Assessment**: 100%

MODERATION ARRANGEMENTS

There shall be provision for both internal and external moderation by qualified moderators and assessors.

RECOGNITION OF PRIOR LEARNING

There will be a provision for awarding the qualification through RPL in line with the ETP RPL Policy.

CREDIT ACCUMULATION AND TRANSFER

Credit Accumulation and Transfer (CAT) will be considered for the award of qualification according to ETP CAT policies.

PROGRESSION PATHWAYS (LEARNING AND EMPLOYMENT)

Learning Pathway: Those who have achieved the qualification can progress as mentioned below

Vertical:

- Since the qualification provides a terminal degree, there will be no vertical articulation beyond NCQF Level 10.

Horizontal:

- Doctor of Philosophy in Electrical Engineering
- Doctor of Philosophy in in Biomedical Engineering
- Doctor of Philosophy in Industrial Electronics Engineering
- Doctor of Philosophy in Communication Engineering

Employment Pathway:

The qualification will produce graduate's suitable positions as

Research Engineer

VLSI Engineer

Instrumentation Engineer

Embedded System Engineer

Circuit Designer

Project Manager

Research Supervisors

QUALIFICATION AWARD AND CERTIFICATION

The learner will be awarded a **"Doctor of Philosophy in Electronics Engineering"** after attaining 360 credits as specified in the rules of combination and credit distribution. Certificate will be awarded to the candidates who have met the qualification requirements.

SUMMARY OF REGIONAL AND INTERNATIONAL COMPARABILITY

Three qualifications were compared with the qualification as follows:

The qualification was compared with various institutions, locally, regionally and internationally running the Ph.D in Electronics Engineering qualifications. The qualification compares very well in terms of learning outcomes, scope of content, level and duration with:

- **PhD: Electrical and Electronic Engineering, The University of Johannesburg, NQF Level 10**
- **PhD Electrical and Electronic Engineering, University of Nottingham, FHEQ level 8**

Summary of Similarities

The comparison has revealed that the proposed Ph.D Electronics Engineering has similar level, credits total, scope of course specialisations, strategies of delivery and common approach to assessment comprising completion of research seminar and dissertation successfully.

All the three (3) institutions cover the domains of the research domain of Electronics Engineering, and they all have the outcome of a final research project. There is a strong similarity in terms of exit level outcomes, these include application of scientific and engineering knowledge**,** problem solving, use of simulation software and real time hardware development, practical skills etc. All the qualifications from the three (3) institutions articulate to a Ph.D degree.

Summary of differences

The difference found is that the proposed qualification also adopts a viva voce form of integrated summative assessment done by internal and external panel of examiners. The University of Johannesburg qualification is offered at a minimum of two years for full time and five years part time., whereas, the University of Nottingham, UK qualification is offered at a minimum of three years for full time and six years part time. The assessment strategies for University of Johannesburg, South Africa are on the outcome of the research component as well as the required coursework in a case where a module was requested to support the project. A professional doctorate is assessed on the outcome of the research Component. The University of Nottingham the students are assessed through tutorials, tests, assignments, and a final year examination scheduled at the end of every semester. The individual project module is continuously assessed in the summer period and concludes with submission of a final project report, as well as an oral assessment based upon the practical demonstration of the proposed engineering design/solution. The proposed qualification follows the benchmarking of the international, national qualification agencies.
REVIEW PERIOD
5 years in line with the NCQF

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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**	