BQA NCQF QUALIFICATION TEMPLATE

SECTION A:	QUALIFICATION DETAILS				
QUALIFICATION DEVELOPER (S)	Botswana International University of Science and Technology				
TITLE	Doctor of Philosophy in Electrical Engineering			**NCQF LEVEL**	10
FIELD	Manufacturing, Engineering and Technology	**SUB-FIELD**	Engineering and Engineering Trades	**CREDIT VALUE**	360
New Qualification	√	*Legacy Qualification*			
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 that 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]. Human Resource Development Council (HRDC) of Botswana has recognized 'Engineering and Technology' as one of the fields that are right now encountering

deficiencies in the labor market (short term) and occupations that show moderately solid business development (long term) (HRDC, 2016)[6].

It is to this effect that the Doctor of Philosophy (Ph.D) in Electrical Engineering qualification is necessary. This is one of the vital engineering qualifications particularly in developing countries like Botswana[7,8]. It provides strong theoretical foundation, practical skills, professional conduct, and critical thinking in Electrical Engineering[9,10].

The PhD Electrical Engineering qualification is developed to contribute for the human capital development and to fulfil the demand gap as per 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 Electrical Engineering in various sectors of the economy (HRDC 2019, Vision 2036, and National Development Plan 11). This qualification helps to build the human capital in the areas of given below for the HRDC – Priority Skills and Employment Trends:

- Designing advanced power systems and control
- Designing advanced high-power electronics devices and its application to industries.
- Designing advanced electric drives and control for industries and special electrical machines.
- Developing and writing software and firmware for power system simulation, operation, and control.
- Designing intelligent distributed energy systems to supply the power to the industries and other consumers.

Aims

The creativity and the scientific knowledge are combined in the electrical engineers for the new ideas and innovations which can be work with the technology, electricity, and system design. Students will have the different options in the specialization like which can work with the circuits, power systems, high voltage engineering, motors and its control, renewable energy sources and power electronics. The electrical engineering developed with the latest changes in the power systems. Particularly Smart Grid techniques to transmit and distribute the power to the consumers by integrating the renewable energy resources into the electrical grid. Electrical networks are integral to modern power grid operations and are becoming increasingly critical as grid dynamics speed up and as more controls become closed loop in form. Existing operation and control (especially remote control) of power systems relies heavily on Supervisory Control and Data Acquisition (SCADA) systems. Power systems have become increasingly interdependent due to advances in sensor, network, and software

technologies that enable more cost-effective means to interconnect grid devices. There is a strong need to increase wide-area situational awareness to coordinate both normal operation and restoration in a more dynamic grid resulting from increasing Variable Energy Resources (VER) and Distributed Energy Resources (DER). 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 emphasizes the dependence of electrical networks that provide these connections to the utility operational systems. It is in this view that the discipline of Electrical Engineering is important to form the Doctor of Philosophy (Ph.D) in Electrical Engineering Qualification.

The qualification allows the students to cover all the basics of electricity, generation of power, transmission of power, control and analysis of power systems, and renewable energy in power systems. The qualified Ph.D. electrical Engineers will be ready to take up employment, and conduct research and innovation in the energy industry on; power systems, electrical machines, smart grids, Electric Hybrid Vehicles, Distributed Energy Resources and Variable Energy Resources to develop the economy and the scientific knowledge pool in Botswana and in the world[6,11-14].

PURPOSE: (itemise exit level outcomes)

The purpose of the qualification is to equip graduates with the most advanced knowledge, skills, and competence to

- Design complete and complex systems in electrical power generation, transmission, and distribution in engineering from the simulation steps to the final realization and able to propose innovative solutions to improve existing systems.
- Demonstrate proficiency in quickly comprehending and adapting to multidisciplinary projects and environments, leveraging the most advanced knowledge to effectively contribute and succeed in high-power engineering.
- Execute engineering projects and proficiently develop products by applying engineering principles independently with minimum supervision using problem-solving skills, and innovative techniques for high-power engineering.
- Effectively 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)
• NCQF level 9 or equivalent in the same field. • Credit Accumulation and Transfer (CAT) and Recognition of Prior Learning (RPL) can be considered for entry according to National CAT and RPL policies.

SECTION B	***QUALIFICATION SPECIFICATION***
GRADUATE PROFILE (LEARNING OUTCOMES)	***ASSESSMENT CRITERIA***
1. Integrate and Innovate Engineering Knowledge: Synthesize and apply advanced principles of power generation, transmission and distribution, high power engineering to model, analyze, and address complex engineering problems, contributing innovative solutions and new knowledge to the field.	1.1 Assess students' ability to integrate and apply advanced principles of power generation, operation and control, transmission and distribution, high power engineering, advanced electrical machines to formulate solutions for complex electrical engineering challenges. 1.2 Evaluate through project-based assessments that require innovative application of engineering knowledge to develop new methods or technologies. 1.3 Recognise the significance of contested scientific knowledge in a contemporary context.
2. Advanced Research and Synthesis: Demonstrate expertise in assessing critically evaluating, and synthesizing scientific information to inform research decisions,	2.1 Measure the capability to assess, critically evaluate, and synthesize scientific and engineering information to support research and innovation in electrical engineering.

methodology development, and innovation in electrical engineering.	2.2 Assess through the submission of research proposals, comprehensive literature reviews, and the synthesis of findings in research papers or dissertations. 2.3 Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using engineering sciences to develop and improve the new advanced electrical engineering products.
3. Practical Engineering Competence: Exhibit profound practical skills and competencies in electrical applications, including the design and implementation of advanced engineering solutions grounded in research findings.	3.1 Evaluate the application of practical skills and competencies in electrical engineering through the design and implementation of advanced engineering solutions. 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 electrical engineering to analyse critical quantities in electrical systems.
4. Professional Communication: 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. Research- Driven Engineering Design: Conduct rigorous engineering design and research projects that employ investigative research, analytical methodologies, and innovative problem-solving techniques to address real-world challenges in electrical 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 electrical engineering. 5.3 Use research-based knowledge and research methods including prediction and modelling to complex electrical engineering activities with an understanding of the limitations.
6. Ethical and Societal Impact: 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.

Note: Please use Arial 11 font for completing the template)

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*	Electrical Engineering Ph.D. Thesis - Concept			10	
	Electrical Engineering Ph.D. Thesis - Proposal			10	
	Electrical Engineering Ph.D. Thesis – Progress			10	

	Electrical Engineering Ph.D. Thesis - Research Phase			10	
	Electrical Engineering Ph.D. Thesis - Dissertation Progress			10	
	Electrical Engineering Ph.D. Thesis – Dissertation Submission Phase			10	360
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-years Doctor of Philosophy (Ph.D.) degree Qualification in **Electrical**, students must have successfully completed a minimum of 360 Credit Units. The Doctor of Philosophy (Ph.D.) program in Electrical Engineering offers an integrated approach of these skills by project-based learning and subject-specific courses. Electrical power-based projects are part of the research. The total study Qualification of 3 years is full time of research.	

(Note: Please use Arial 11 font for completing the template)

ASSESSMENT ARRANGEMENTS

The Ph.D. in Electrical Engineering qualification is designed to ensure a comprehensive evaluation of students' knowledge, skills, and competencies aligned with the qualification's exit-level outcomes. The assessment strategy encompasses both formative and summative assessments, each serving a distinct purpose in the learning and evaluation process.

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

MODERATION ARRANGEMENTS

Appointment of Internal Examiners

The Ph.D. in Electrical Engineering qualification incorporates robust moderation processes to ensure the quality and integrity of student assessments, aligning with the program's commitment to academic excellence. There shall be provision for both internal and external moderation by BQA accredited or equivalent moderators and assessors.

RECOGNITION OF PRIOR LEARNING

There shall be provision for award through RPL according to the institutions RPL and national policies

CREDIT ACCUMULATION AND TRANSFER

CAT will be considered for award of Qualification according to national 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:

A Doctor of Philosophy in Electrical Engineering candidate could continue to pursue a Doctor of Philosophy program in any other university in the Electrical specialized disciplines such as;

- Doctor of Philosophy in Electronics Engineering
- Doctor of Philosophy in in Energy Engineering
- Doctor of Philosophy in Power Engineering

Employment Pathway:

The qualification will produce graduate's suitable positions as

Research Engineer

Control Engineer

Power Plant Manager

Energy Engineer

Circuit Designer

Project Manager

Lecturers

Research Supervisors

Entrepreneurs

QUALIFICATION AWARD AND CERTIFICATION

The learner will be awarded a **"Doctor of Philosophy in Electrical 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 Electrical 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, NCQF Level 10**
- **PhD Electrical Engineering, University of Cape Town, NQF Level 10**

- **PhD Electrical and Electronic Engineering, University of Nottingham, FHEQ level 8**
- **PhD Electrical Engineering, BIUST, NQF level 10**

Summary of Similarities

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

All three (3) institutions cover the domains of research domain of Electrical 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 the 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 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 panels of examiners. The University of Cape Town qualification is offered at a minimum of two years for full-time and five years part-time which is like the University of Johannesburg, South Africa, 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 the University of Cape Town and the 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. At 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 the 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, and national qualification agencies.

Comparability matrix given in Appendix 2

REVIEW PERIOD

5 years in line with the NCQF

OTHER INFORMATION

References

1. The Global Innovation Index: Winning with Global Innovating, Cornell University, INSEAD, World Intellectual Property Organization, 2020. https://www.wipo.int/edocs/pubdocs/en/wipo_pub_gii_2020.pdf
2. The National Policy on Research, Science, Technology and Innovation, Ministry of Infrastructure, Science and Technology, 2011.
3. Vision 2036, prepared by the vision 2036 presidential task team, Published by Lentswe LA Lesedi (Pty) Ltd, July 2016
4. National Development Plan 11 April 2017 –March 2023, Volume I, Ministry of Finance and Development Planning, SEPTEMBER 2016
5. The National Human Resource Strategy (2009 – 2022): Realising our Potentials, Ministry of Education and Skills Development, Republic of Botswana, November 2009.
6. HRDC Annual report 2016.
7. The National Policy on Research, Science, Technology and Innovation, Ministry of Infrastructure, Science and Technology, 2011.
8. The National Human Resource Strategy (2009 – 2022): Realizing our Potentials, Ministry of Education and Skills Development, Republic of Botswana, November 2009.
9. The Human Resource Development Strategy for South Africa (2010 – 2030), March 2009.
10. The Joint Task Force for Computing Curricula 2005: The Overview Report covering undergraduate degree programs.
11. Engineering Registration Board of Botswana: http://www.erb.org.bw/
12. The South African Qualifications Authority, Level Descriptors for the South African National Qualifications Framework, November 2012.
13. Anderson LW and Krathwohl D. *Taxonomy for learning, teaching, and assessing: a revision of Bloom's taxonomy of educational objective,* 2001. New York: Longman.
14. https://www.eecs.mit.edu/

(Note: Please use Arial 11 font for completing the template)

For Official Use Only:

CODE (ID)	

REGISTRATION STATUS	BQA DECISION NO.	REGISTRATION START DATE	REGISTRATION END DATE
LAST DATE FOR ENROLMENT		LAST DATE FOR ACHIEVEMENT	