SECTION A:	***QUALIFICATION DETAILS***																	
QUALIFICATION DEVELOPER (S)	New Era College of Arts, Science and Technology																	
TITLE	Diploma in Electrical and Electronics Engineering															***NCQF LEVEL***	6	
FIELD	Manufacturing, Engineering and Technology		***SUB-FIELD***	Electrical and Electronics												***CREDIT VALUE***	*380*	
New Qualification								√	*Review of Existing 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 for the Qualification:

The current economic, social, demography, political and technological changes both nationally and internationally demand a frequent review of qualifications and learning programs to suit the current global trends. During the process of developing this qualification, the developer undertook extensive surveys and consultations with major stakeholders such as government, industry, donors and other institutions of higher

learning in the region. During these consultations it emerged that more specialisation diploma in electrical and electronic engineering was necessary, hence the development of this qualification.

The needs assessment on the relevance of the Diploma in electrical and Electronic Engineering qualification to Botswana was conducted. The relevant industry was visited which included the mining sector, manufacturing sector, construction industry, education sector and Government departments. The findings from this survey showed the growing needs of electrical technicians and electrical technologists in all sectors. Hence the development of this qualification. Furthermore, a survey on the needs of the industries that was conducted, and the outcomes clearly pointed out on the need to offer the vocations on a more enhanced practical approach, to produce graduates who are more oriented to hands on skills and fit for the industry at the end of their studies.

This qualification is very important in supporting the current educational needs for Botswana. It fully supports Government efforts to achieve energy security as enunciated in the strategy for energy sector in the NDP 9/10 which aims to improve the electricity supply through grid expansion by supporting renewable energy generation by Independent Power Producers. To achieve this, the need for skilled Diploma in Electrical and Electronic Engineering Technologists and Technicians who are equipped with both practical skills and management skills at production level cannot be emphasized.

In their report, (Human Resource Development Council (HRDC) Top 20 Occupation report, 2016), the HRDC highlighted electrical and electronics skills as needed in the following cross cutting industrial sectors: research and innovations sector (Energy Security and Electronics Systems), Mining, Minerals, Energy and Water (MMEWR) sector (Integrated Energy Planning, Solar Systems, Electronics Engineer), Research and Innovation sector (Electronic Systems) and Manufacturing Sector (Electrical and Electronics Engineering).

The Vision 2036 strategic report: Achieving Prosperity (2016) envisions a sustainable environment (Pillar 3) by declaring that “Botswana will be energy secure, with diversified safe and clean energy sources, and a net energy exporter” (pg24). These achievements can only be achieved through a through human resource capital development in Electrical and Electronics Engineering as advocated by Vision 2036 strategic report:

Achieving Prosperity (2016). Botswana National Strategic Development Plans 9, 10 and 11 (NSDP) and the Vision 2036 plan informs on the need to establish the country’s Electrical & Electronic infrastructure that should assist in developing Botswana’s sustainable plan for energy generation hence assist economy

diversification.

The National Development Plan strategic reports (9, 10 and 11) advocates for Botswana to engage in research and development and determine clear strategic solutions electrical power generation and skills required. Currently Botswana has a strong dependency on imported fuel such as oil and electricity. In 2012, the government spent about P5 billion from the Southern African Power Pool (SAAP) and SADC (The Botswana Gazette, 2017) and the article by Botswana Business Day reports that, Botswana Power Corporation has continuously made operating losses for years due to high electrical energy import costs, non-performing assets and operational inefficiency, hence the parasternal has relied on government subsidy and they have been forced to review energy tariffs (Botswana Business Day, 2018).

The Botswana Energy Sector Policy Brief of 2012 reports that Botswana's domestic energy-related resources present immense opportunities for addressing her energy insecurities and increasing access to energy services. The abundance of sunlight, coal and cow-dung forms the basis of such opportunities. The most significant input is the technology required to leverage the energy latent in these resources.

PURPOSE:

The purpose of this qualification is to equip graduates with knowledge, skills, and competence to:

- Design electrical systems
- Install electrical and control systems
- Offer technical support to subordinates
- Maintain electrical control systems
- Install, test and commission electrical installation and electrical equipment
- Manage electrical Energy systems.
- Uphold Safety, Health, Environment and Quality (SHEQ)
- Install software/hardware (PLCs,)
- Apply communication skills
- Interpret Engineering drawing
- Apply Entrepreneurial skills

Graduates would engage in employment in Public and Private Electrical Engineering Organizations. They will get career positions as Certified Electrical technicians or technologist through the Botswana Engineers Registration Board (ERB). The graduate will have knowledge, skills and competencies in Engineering Science, Computer Aided Design for Electrical Engineers.

ENTRY REQUIREMENTS (including access and inclusion)

Minimum entry requirement:

- Certificate IV, NCQF Level 4 (General Education or TVET) or equivalent with passes in 5 subjects including English, Mathematics and Physics.
- Access through Recognition of Prior Learning (RPL) and Credit Accumulation and Transfer (CAT) will be provided through ETP policies in line with National RPL and CAT Policies.

SECTION B	***QUALIFICATION SPECIFICATION***
GRADUATE PROFILE (LEARNING OUTCOMES)	***ASSESSMENT CRITERIA***
Analyse parts of an overhead transmission line, underground cables	• Analyse Line parameters, Short and Medium Lines • Analyse Sag, Tension, wind and Ice loading

	• Analyse Corona, Skin and Ferranti Effect • Analyse Lightning Protection. • Identify Conductor materials, Line Supports, • Analyse and identify Insulators • Identify types of cables • analyse Loss Angle, Voids etc. Examine stress in cables
Examine parts of a distribution network alternating current and direct current	• Describe Radial network Alternating Current and Direct Current • analyse Ring network Alternating Current and Direct Current • analyse Service Mains
Describe types of equipment on typical substations	• Describe types of Substations • Identify types of Equipment • Recognize types of Switching station
Interpret the operation of induction motors and of direct current (dc) machines and analyse the importance of power factor (PF) in a supply system	• Identify General Construction, Direct Current Generation • Interpret Direct Current Motors • Interpret Three-phase Squirrel Cage Induction Motor (SCIM's) • Interpret Three-phase Wound Rotor Induction Motor (WRIM's) • Interpret Three-phase Induction Motors • analyse Power Factor (PF) and Savings by Power Factor (PF) correction • analyse Economic Power Factor (PF)
Interpret the operation of transformers	• Interpret Single-phase transformers • Interpret Three-phase transformers • Interpret Autotransformers

	• Interpret Current and Voltage transformers.
Conduct a practical work on electronics design	• Use Properties of Semiconductor Crystals • Use Doped Semiconductors • Use p-n Junction • Apply Device Characteristics. • Apply Bias arrangement • Apply Alternating Current circuit examples • Use Single and multistage Stage amplifiers • Use Differential and Operational Amplifiers (Op - Amp) • Use Identify Light Emitting Diodes (LED's) • Identify Laser Diode • Identify Unijunction Transistors (UJT) • Identify Thyristors • Use RC/RL Passive filters • Use RC/RL Active filters • Use Filter transformation • Oscillations • Use Electrical symbols • Apply theory on control devices • Use types of diagrams
Apply programmable logic controllers (PLC's) to design manual/automatic electromechanical control circuits	• Apply Architecture (Hardware) • Apply Boolean Algebra • Apply Conversion of electromechanical to Logic circuits • Apply Programming techniques • Design Typical ON-OFF control circuits • Design timing ON-OFF control circuits • Design Direct Current and Alternating Current motor control circuits

Apply theory of probability to solve problems	• Use principles of probability • Solve problems on simple probability • Solve problems involving probability distribution • Apply significant testing
Apply geometry and calculus to solve mathematical problems	• Solve problems involving straight lines • Solve problems involving the circle theorem • Solve problems involving ellipse • Solve problems involving parabola • Solve problems involving hyperbola • Apply first principles of differentiation • Use techniques of differentiation • Apply differentiation • Use techniques of integration • Apply integration • Use Laplace transform • Solve arithmetic progression • Solve geometric progressions • Solve binomial series problems • Solve Fourier series
Describe the concepts of different number systems	• Apply decimal number system • Apply binary number system • Apply Octal number system • Apply hexadecimal number system • Apply code
Apply the knowledge of Digital electronics in designing different circuits and microcomputer systems	• Apply Basic building blocks • Apply Boolean algebraic Laws/Rules and postulates • Apply Combinational logic • Apply Karnaugh maps • Apply Flip-flops

	• Apply Counters and Registers • Apply Multi/demultiplexing • Apply Block definition of microcomputer • Apply Microprocessor based system • Apply Microcontroller
Analyse types of generating stations common in Botswana.	• Analyse renewable energy technology • Analyse Diesel Power Stations • Analyse Thermal Power Stations
Apply entrepreneurship concepts in Establishing business enterprises and to develop entrepreneurial competencies and attitudes	• Identify entrepreneurial concepts • Develop entrepreneurial competencies and attitudes • Identify economic trends in Botswana • Apply Government policy on Enterprise development • Develop self-motivation • Develop Business Opportunities • Network enterprise development • Develop effective Business Communication skills • Apply managerial and leadership skills in an enterprise • Apply product marketing skills • Keep business record • Apply principles of costing and pricing of production/services • Apply enterprise and technology principles • Apply business ethics and value in managing an enterprise • Write a business plan/project • Start business enterprise • Establish procedures for formalizing an enterprise • Establish methods of resource mobilization

Design models and plans of unfamiliar and ill-defined problems including the choice of appropriate and relevant Electrical and Electronic technologies using the concepts of Control Theory and PLCs	• Use Manual control devices • Use Semi-automatic devices • Use Automatic control devices • Identify Open-loop control systems • Identify closed-loop control systems • Use Transducers to pick-up signals from physical quantities • Use Transducers to pick-up signals from fluid quantities • Use Transducers to pick-up signals from electrical quantities • Use Transducers to pick-up signals from other quantities • Apply Block diagram manipulation • Apply Open-loop and closed-loop representation • Apply differential and integral expressions into Block diagrams • Apply Systems response to forcing function • Apply Frequency or S-domain representation of the characteristic response • Apply Time-domain representation of the characteristic response • Apply Bode plots • Apply Root Locus plots • Apply Nyquist plots
Construct and troubleshoot Power Electronic Circuits using the appropriate electronic components	• Apply the construction, characteristic and • applications of silicon-controlled rectifiers including IGBT's and MCT's, power MOSFET's SIT's

	• Apply the construction, characteristics, and applications of control devices such as 555timer IC's, BJT's, UJT's, low power FET's Op-Amps • Apply Opto – couplers • Use of control circuits • Use Device protection • Configure Power Converters and Inverters • Configure UPS and SMPS systems • Configure DC and AC motor control
analyse the operation of Merz-Price protection system and determine type of fault on the system	• analyse the operation of Merz-Price protection system • Determine type of fault of the system • Identify the principal operation Electromagnetic Attraction type (Instantaneous) • Identify the principal operation of Induction type i.e. Shaded-pole Over-current type (non-directional) • Identify the principal operation of Induction type (directional) • Identify the principal operation of Distance / Impedance type • Use fuses, lightening arrestor, Circuit breakers • Identify current-limit devices • Identify Unit or Restricted protection • Identify Unrestricted protection
Operate synchronous machines	• Operate three-phase Synchronous Generator (Alternator) • Operate three-phase Synchronous Motor • Operate three-phase Synchronous Capacitor • Explain the concepts of Transformers
Apply communication skills	• Recognize the nature and purpose of communication.

	• Identify the communication process. • Identify barriers of effective communication • Apply strategies of effective communication • Identify the flow of communication in organization • Acquire skills for intensive reading • Develop appropriate writing skills • Develop listening and speaking skills • Write different types of letters • Respond to memorandum and carry out appropriate action • Respond to circulars and carry appropriate action. • Complete forms and documents. • Apply research techniques • Differentiate types of reports • Use report format • Compose different types of report • Write a proposal • Consult with colleagues, Supervisors and organizations correctly • Carry out joint considerations of problems • correctly • Receive instructions correctly • Participate in decision making • Handle customers correctly • Get or grant permissions correctly • Write an application letter • Write Curriculum Vitae • Prepare for interviews

Interpret Engineering drawing	• Produce Conventions for screw thread, internal and external • Produce Symbols for electrical, electronic sectioning and screw threads • Produce engineering Abbreviations for associated terms • Produce types of Line • Apply types of lines • Produce geometrical figures • Produces drawings to scale • Produce Dimensioned drawings • Produce engineering drawings • Produce electrical symbols and drawings • Produce electronic symbols and drawings • Produce Printed Circuits (PC) board drawing

SECTION C	***QUALIFICATION STRUCTURE***					
COMPONENT	***TITLE***	***Credits Per Relevant NCQF Level***				***Total (Per** Subject/ Course/ Module/ Units)*
		Level [5]	***Level [6]***	***Level [7]***	***Level [8]***	

FUNDAMENTAL COMPONENT *Subjects/ Courses/ Modules/Units*	End User Computing	10				10
	Engineering Mathematics I,II,III & IV	20	20			40
	Engineering Science	20				20
	Introduction to Programming	15				15
	Professional Communication & Skills for Engineers.	10				10
	Fundamentals of Electrical Engineering	10				10
	Engineering Drawing	10				10
	Entrepreneurship and Economic development		10			10
CORE COMPONENT *Subjects/Courses/ Modules/Units*	Electrical and Electronics Workshop	15				15
	Electricity and Magnetism		15			15
	Electromagnetic Theory		15			15
	C++ Programming		15			15
	Circuit Theory (DC +AC) Principles	10	10			20
	Analogue Electronics		15			15

	Digital Electronics System		15			15
	Electrical Machines		15			15
	Electrical Power Systems		10			10
	Electrical Instrumentation		10			10
	Measurement Systems		10			10
	Engineering Project		30			30
	Industrial Training		50			50
ELECTIVE/ OPTIONAL COMPONENT *Subjects/Courses/ Modules/Units* **Choose TWO**	Electrical Motor Control		10			*10*
	Supervisory Control and Data Acquisition (SCADA)		10			
	Power Electronics		10			
	Electrical Protection		10			
	Automatic Control Systems		10			

SUMMARY OF CREDIT DISTRIBUTION FOR EACH COMPONENT PER NCQF LEVEL	
TOTAL CREDITS PER NCQF LEVEL	
NCQF Level	***Credit Value***
Level - 5	***120***
Level - 6	***260***
TOTAL CREDITS	***380***

Rules of Combination:

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

Rules of the Qualification

The qualification rules constitute a combination of:

(a) Elective modules (**Learner will choose two electives**)
(b) Core modules which are compulsory
(c) Fundamental's modules which are also compulsory
(d) To graduate a candidate should have completed 380 credits.

Qualification Combination Rules Based on Module Status per NCQF designation of: Fundamental, Core & Electives

- Core modules have 235 credits.
- Fundamental modules have 125 credits.
- Elective modules have 20 credits

Qualification Rule of Credit Distribution Based on NCQF Levels from Level 5 and Level 6 is given below.

- NCQF Level 5 Modules: 120 Credits

▪ NCQF Level 6 Modules: 260 Credits

ASSESSMENT ARRANGEMENTS
All assessments, formative and summative, leading/contributing to the award of credits or a qualification should be based on learning outcomes and/or sub-outcomes. **Summative assessment** The Final Examination contributes to **60%** of the final grade. **Formative assessment** Formative assessments contribute to **40%** of the final grade.
MODERATION ARRANGEMENTS
Assessment and moderation shall be carried as per ETP's policies, which are aligned to BQA/ National policies. The ETP will engage only BQA accredited assessors and moderators to carry out assessment and moderation.'
RECOGNITION OF PRIOR LEARNING
There will be provision for awarding of the qualification through RPL mode which will be in line with the national RPL Policy.
CREDIT ACCUMULATION AND TRANSFER
There will also be provision of awarding credits to the learner in a case where they do not complete the qualification or transfer to another institution.
PROGRESSION PATHWAYS (LEARNING AND EMPLOYMENT)
Learning Pathways

It allows learners to progress into employment or continue and pursue Bachelor of Engineering Degree in Electrical and Electronic Engineering.

This Diploma is also aimed at learners who

- Wish to progress to Bachelor of Engineering Degree in electrical and electronic engineering at any renowned universities.
- Wish to gain employment as an Engineering Technician or Technologist.
- It is also aimed to contribute to recognition by professional institutions.

Horizontal articulation of the qualification

- Level 6 qualifications in Technical Teaching
- Level 6 qualifications in Project Management
- Level 6 Qualification Diploma in AutoCAD

Vertical articulation of the qualification

- Level 8 qualifications in BEng. (Hons) Electrical and Electronics Engineering
- Level 8 qualifications in BEng. (Hons) Telecommunications Engineering
- Level 8 qualifications in BEng. (Hons) Computer Engineering
- Level 8 qualifications in BEng. (Hons) Networking Engineering
- Level 8 qualifications in BEng. (Hons) Software Engineering

Employment Pathways

Graduates of the course may find employment in a range of public and private organisations for the following posts.

Typical roles include in Electrical and Electronics domains and those related as

- Electrical Technologist,
- Electrical & Electronics Project Supervisor,
- Electronics Technician
- Power Technician

- Consultant
- Electrical & Electronics Lecturer-Level 5
- Solar Systems Technologist

QUALIFICATION AWARD AND CERTIFICATION

Minimum Standard of achievement for the award of the qualification.

To be awarded the qualification the graduate, must complete 125 Credits of the Fundamental Component, 235 Credits of the Core component and 20 credits of the Elective component to make a total of 380 credits.

Certification

Students should pass all modules for the **Diploma in Electrical and Electronics Engineering** to be awarded the qualification according to the standards prescribed for the award of the qualification and applicable policies.

REGIONAL AND INTERNATIONAL COMPARABILITY

The bench marking for this curriculum was done with several renowned universities and colleges both locally and internationally. The comparison revealed that Diploma in electrical and electronic engineering was found to compete favourably.

The Universities and colleges which where bench marked with include though not limited to: The Copperbelt University from Zambia, City and Guilds franchised programme to mention but a few.

REVIEW PERIOD

This qualification will be reviewed every 5 years.

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