SECTION A:	QUALIFICATION DETAILS																
QUALIFICATION DEVELOPER (S)	Department of Teacher Training andTechnical Education																
TITLE	Diploma in Control and Instrumentation Engineering													NCQF LEVEL	6		
STRANDS (where applicable)	N/A																
FIELD	Manufacturing, Engineering and Technology		SUB-FIELD		Engineering and Engineering Trades									CREDIT VALUE	364		
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:

Control and Instrumentation have been identified as one of the occupations in high demand in Botswana and beyond. The occupations or the skills are needed by the energy, water, mining, and mineral sectors respectively. This is based on the Labour Market Analysis conducted by the HRDC.

The qualification Diploma in Control & Instrumentation Engineering is developed as a response to the need established by Human Resource Development Council Report (HRDC 2019) on Top Occupations in Demand, which identified Control & Instrumentation Technicians as one of the occupations in high demand in Botswana. HRDC report of 2023/2024 on the consolidated list of priority occupations and skills list control and instrumentation technicians as a priority occupation, and recommends associated technical skills such as Machinery maintenance, calibration and repairs, Good Manufacturing Practice (GMP) compliance procedure,

Industrial system control & Network technologies, Electronics, control & instrumentation and soft skills like problem-solving, attention to details, professionalism, and good record keeping.

This qualification has been developed in line with the Botswana Government's Vision 2036 which acknowledges Technical and Vocational Education Training (TVET) as one of the key contributors to economic growth and employment creation (page 17) and NDP11 (page 71) The Vision further emphasizes the implementation of the curriculum which is aligned to the needs of the economy, business, science, mathematics and technology (page 20).

In addition, the Continental Education Strategy for Africa 2016 – 2025 stipulates that there is a need to expand TVET opportunities at both secondary and tertiary levels and strengthen the linkage between the world of work and education and training systems.

Control & Instrumentation is one of the scarce skills in the country, especially in the Mining, Minerals, Energy, Water Recourses, Agriculture and Manufacturing sectors. Vision 2036 also advocates for a knowledge-based economy which will enhance entrepreneurship skills for graduates and all citizens therefore this qualification addresses the National Vision objective. Generally, there is a shortage of Artisans and Technicians therefore enrollment in this qualification will address this acute shortage. As a result of the skills shortage, the country and the industry affected import technicians and the Government sponsors the students to study Control and Instrumentation Programme outside the country at the Diploma level for the TVET sector. In this regard, it becomes expensive, and the numbers of graduates are limited. Furthermore, there is a need to offer the programme locally to meet the demand and reduce costs.

It has always been believed that vocational education especially in the Botswana context is for the illiterate or those who did not perform well at both basic and secondary school but that is not the case. Technical Vocational Education and Training is for people who are more into hands-on practical skills rather than academic or aiming for a blue-collar job.

The qualification is another way of establishing a positive image for improved perception of the TVET sector. It increases enrollment and at the same time addresses the alignment of TVET programmes. Institutions will create demand for qualified, productive, and competitive human resources as stated in Education Training Strategic & Sector Plan (ETSSP) Pg 98.

PURPOSE: (itemise exit level outcomes)

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

- Install program, troubleshoot, and adjust electrical and mechanical equipment, instrumentation, and related systems.
- Perform tests and maintenance on mechanical, electrical and instrumentation equipment.
- Interpret equipment readings and outputs; ensure proper equipment functioning.
- Read and interpret wiring diagrams, mechanical drawings, and specifications related to installations or repair work.

- Make verbal and written reports of work performed and perform record-keeping functions.
- Initiate work orders and ensures that orders are accurate and complete.
- Troubleshoot Telemetry software and hardware issues; develop recommendations for change/modification; implements and documents changes applied to the software and hardware.
- Perform basic programming for Programmable Logic Controllers, including installing software and diagnosing and troubleshooting issues.

MINIMUM ENTRY REQUIREMENTS (including access and inclusion)

Minimum entry requirement for this qualification is as follows:

- Certificate IV, NCQF Level 4 or equivalent.
- Applicants who do not meet minimum entry will be absorbed through Recognition of Prior Learning (RPL) and Credit Accumulation and Transfer (CAT) according to the ETP's policies aligned to BQA RPL and CAT policies

SECTION B	***QUALIFICATION SPECIFICATION***
GRADUATE PROFILE (LEARNING OUTCOMES)	***ASSESSMENT CRITERIA***
1. Assemble and install electrical and electronics equipment for control and instrumentation field.	1.1 apply electrical and electronics installation repair standards in control and instrumentation field. 1.2 Identify and prepare tools and components used in an electrical workshop. 1.3 Carryout electrical installations in commercial, industrial, and domestic set up. 1.4 Assemble electronics circuit.
2. Diagnose and rectify faults in analogue, digital circuits, and components in electronic control systems.	2.1 Identify and assemble analogue electronic components. 2.2 Test and troubleshoot analogue electronic circuits Identify and assemble digital electronic components. 2.3 Test and troubleshoot digital electronic circuits.
3. Apply analogue and digital communication skills in Control Systems for installing, diagnosing, and repairing communication equipments.	3.1 Employ knowledge and understanding of bus systems used in control systems. 3.2 Examine the purpose, structure, and application of different communication systems. 3.3 Install, diagnose, and repair communication equipment adhering to the set standards and manufactures specifications.
4. Carry out installation, maintenance, and service of electronic equipment.	4.1 Calibrate measuring instruments according to the set standards. 4.2 Prepare tools and equipment for carrying out maintenance activities. 4.3 Perform installation and commissioning of electronic equipment according to applicable maintenance procedures and standards. 4.4 Perform maintenance and service on electronic equipment.
5. Design engineering drawings used in Control & Instrumentation(C&I) engineering industry.	5.1 Examine the symbols associated with mechanical, electrical, electronic and instrumentation diagrams. 5.2 Analyse different types of C&I engineering diagrams and associated documentation. 5.3 Draw and develop C&I engineering diagrams using application software.

6. Apply professional (generic/soft skills) applicable in control and instrumentation engineering field.	6.1 Employ ICT skills in control & instrumentation engineering to execute the assigned tasks. 6.2 Communicate effectively and efficiently in Control and Instrumentation discipline/ field. 6.3 Apply entrepreneurship practical skills in a business set up. 6.4 Execute administrative duties within control & instrumentation discipline. 6.5 Employ the skill to carryout research in control & instrumentation discipline. 6.6 Apply code of ethics for engineers in work environment.
7. Evaluate types of sensors and transducers in control and instrumentation engineering.	7.1 Employ the skill to analyse types of sensors and transducers. 7.2 Prepare appropriate transducers relating to processes. 7.3 Apply signal conditioning techniques in control and instrumentation set up.
8. Apply knowledge and skill to diagnose electronic power control devices in industrial automation.	8.1 Examine power control devices for applicable processes. 8.2 Analys the principles of power electronics and control. 8.3 Install and commission power control systems/ devices. 8.4 Perform troubleshooting and repair of power electronics devices.
9. Apply knowledge and skill of process control in servicing and maintaining measurement and instrumentation systems.	9.1 Analyse principles of operations of process parameters. 9.2 Carryout installation and commissioning of industrial instrumentation and control systems. 9.3 Analyse process control concepts. 9.4 Employ the skills to work with Engineering application software's.
10. Apply intelligent automation techniques in industrial process control.	10.1 Explore the origins, architecture, and applications, of Programmable Logic Controllers (PLC), SCADA, DCS 10.2 Carry out installation, configuration, and commissioning of control systems. 10.3 Carry out maintenance of control systems.
11. Apply safety, health, and environmental measures in the workplace.	11.1 Adhere to safety, health, and environmental policies in the workplace. 11.2 Adhere to safety, health and environmental regulations in the workplace to minimise risks and

	accidents. 11.3 Administer first aid according to the required standards. 11.4 Comply to safety, health and environmental reporting procedures for injuries and accidents in the workplace.
12. Apply engineering mathematics skills to analyse systems in control and instrumentation discipline.	12.1 Perform calculations in order to solve problems. within control and instrumentation engineering field. 12.2 Apply mathematical concepts and principles in field of control and instrumentation engineering. 12.3 Perform calculations on control and instrumentation engineering systems.

SECTION C	***QUALIFICATION STRUCTURE***				
COMPONENT	***TITLE***	***Credits Per Relevant NCQF Level***			***Total Credits***
		Level [ ]	***Level [5]***	***Level [6]***	
FUNDAMENTAL COMPONENT *Subjects/ Courses/ Modules/Units*	Occupational Health & Safety		***6***		***6***
	Introduction to computing		***8***		***8***
	Entrepreneurship		***8***		***8***
	Introduction to Research Methodology			***8***	***8***
	Communication Skills		***8***		***8***
CORE COMPONENT *Subjects/Courses/ Modules/Units*	Engineering Mathematics		***18***	***18***	***36***
	Electrical W/Practice		***14***		***14***
	Electrical Engineering		***24***		***24***
	Electrical Engineering Drawing		***10***		***10***
	Electronics		***14***	***14***	***28***
	Measurement and Instrumentation		***12***		***12***
	Electrical Computer Aided Drawing			***10***	***10***
	Power Electronics			***12***	***12***

	Control Systems			***14***	***14***
	Process Control Systems			***13***	***13***
	Industrial Automation Systems			***18***	***18***
	Process Instrumentation			***13***	***13***
	Microprocessor Based System			***12***	***12***
	Engineering Ethics			***8***	***8***
	Data Communication and Networks			***12***	***12***
	Integrated Research Project			***30***	***30***
	Work-placement			***60***	***60***
STRANDS/ SPECIALIZATION	*Subjects/ Courses/ Modules/Units*	***Credits Per Relevant NCQF Level***			***Total Credits***
		Level [ ]	***Level [ ]***	***Level [ ]***	
1.	***N/A***				

2.	***N/A***				
Electives	***N/A***				

SUMMARY OF CREDIT DISTRIBUTION FOR EACH COMPONENT PER NCQF LEVEL	
TOTAL CREDITS PER NCQF LEVEL	
NCQF Level	***Credit Value***
Level 5	***122***
Level 6	***242***
TOTAL CREDITS	***364***

Rules of Combination:

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

Modules at level 5 consists of credits to the value of **122** all of which are compulsory

Modules at level 6 consists of credits to the total value of **242** all of which are compulsory

The candidate has to pass all core modules and fundamentals modules.

N.B. There are no electives for this qualification

ASSESSMENT ARRANGEMENTS

Documentation

All necessary documents including qualification documents, alignment matrices, assessment instruments and Assessment criteria/rubrics should be available.

Formative (60%)

The contribution of formative assessment to the final grading shall be 60%.

Summative Assessment (40%)

The contribution of summative assessment to the final grade shall be 40%.

Assessment shall be carried out by BQA registered and accredited Assessors.

MODERATION ARRANGEMENTS

Internal and external moderators to be engaged will be BQA accredited subject specialists in relevant fields with relevant industry experience and academic qualification. Moderation will be done by BQA accredited persons in line with ETP policy which is aligned to National policy on the same. The moderators should be holders of Bachelor of Engineering in Control & Instrumentation, Bachelor of Engineering in Industrial Automation and Robotics Engineering, Bachelor of Engineering in Mechatronics and Industrial Instrumentation Engineering, Bachelor of Engineering in Electrical and Electronics Engineering, Bachelor of Engineering in Electronics Engineering , relevant/similar qualifications and industrial experience will be an added advantage

RECOGNITION OF PRIOR LEARNING

Recognition of Prior Learning (RPL) will be considered for the award of the credits according to applicable RPL policies

CREDIT ACCUMULATION AND TRANSFER

Credit Accumulation and Transfer will be considered for the award of the credits according to applicable RPL policies

PROGRESSION PATHWAYS (LEARNING AND EMPLOYMENT)

LEARNING PATHWAYS

Horizontal Articulation (related qualifications of similar level that graduates may consider)

- Diploma in Electrical & Electronics Engineering
- Diploma in Industrial Automation Engineering
- Diploma in Instrumentation Engineering

Graduates may consider undertaking professional certifications since vendor training is recognized internationally as an industry benchmark for product specific training.

Vertical Articulation(qualifications to which the holder may progress to)

- Bachelor in Control and Instrumentation Engineering
- Bachelor in Mechatronics and Industrial Instrumentation Engineering
- Bachelor in Industrial Automation and Robotics Engineering
- Bachelor in Electrical and Electronics Engineering
- Bachelor in Electronics Engineering

Employment Pathways

- On successful completion of this qualification the holder may be absorbed in the job market as:

- Control and Instrumentation Technician
- Automation and Information Software Technician
- Automation and Information Maintenance Technician
- Security Maintenance Technician
- Control and Instrumentation Sales Technician
- Clinical Instrumentation Technician
- Analytical Instrument Technician
- Instrumentation Lab Technician

QUALIFICATION AWARD AND CERTIFICATION

Qualification Award

- Candidate meeting the required minimum of 364 credits will be awarded Diploma in Control and Instrumentation Engineering in accordance with the qualification composition rules and applicable policies.

Certification

- There will be certification upon awarding of Diploma in Control & Instrumentation Engineering qualification.

SUMMARY OF REGIONAL AND INTERNATIONAL COMPARABILITY

Similarities:
Similarities:

Title of Qualifications

The qualifications benchmarked with have similar qualification titles with the developed qualification: Industries Skills Council of Australia's qualification is titled Diploma of Instrumentation and Control Engineering; Scotland qualification is titled Advanced Certificate/Diploma in Measurement and Control Engineering whereas the proposed qualification is Diploma in Control and Instrumentation Engineering.

Duration and Level

The duration of the qualification published by Industries Skills Council of Australia's (Diploma of Instrumentation and Control Engineering) is between 1-2 years, whereas for Scotland qualification (Advanced Certificate/Diploma in Measurement and Control Engineering) duration is 3 years, and the developed qualification (Diploma in Control and Instrumentation Engineering) is 3 years. The developed qualification has two entry levels which is for the holders of NQF Level 4 qualification and NQF Level 5 qualification. The Industries Skills Council of Australia qualification entry is NQF level 5 hence the shorter duration to graduation For Scotland entry is NQF Level 4 and 5. Those entering with NQF level 4 therefore may require up to 3 years to complete their studies. All the qualifications therefore share same duration and time taken to graduate depends on level of entry.

Main Exit outcomes

The benchmarked qualifications and the developed qualification have similar competencies such as Install instrumentation and control apparatus and associated equipment, apply the principles of electrical and electronic engineering to circuits, and assemble and install electrical and electronics equipment for control and instrumentation field etc.

Modules

The modules for the benchmarked are the same as the proposed qualification examples include engineering mathematics, process control, and process instrumentation (Instrumentation in Hazardous Areas for Scotland), Microprocessor Based Systems (Microprocessor and micro-Controller for Australia and Microprocessor and Microcontroller Technology for Scotland.

Assessment strategies and Weightings

The proposed qualifications do have formative and summative assessments.

Qualification rules and minimum Standards for the award of the qualification

The proposed qualification and the benchmarked have stated that the candidate has to certify all the set minimum standards (such as all the modules should be passed) of the qualification in order to be awarded a diploma.

Differences

The minor difference is the naming of qualifications modules but still in terms of content meaning the same thing e.g., Microprocessor and Microcontroller Technology (Scotland)., Microprocessor and micro-Controller (Australia) and Microprocessor Based Systems (the developed qualification).

Learning and study pathways

- The graduates of the developed qualification can articulate horizontally (NQF Level 6) into qualifications like Diploma in Electrical Electronics Engineering, Diploma in Industrial Automation Engineering, Diploma in Instrumentation Engineering.
- Graduate can articulate vertically to NQF Level 7(Bachelor's Degree) like Bachelor in Control and Instrumentation Engineering, Bachelor in Mechatronics and Industrial Instrumentation Engineering, Bachelor in Industrial Automation and Robotics Engineering, Bachelor in Electrical and Electronics Engineering, Bachelor in Electronics Engineering.
- Graduates of Diploma in Control and Instrumentation can be employed locally and internationally as Controllers and in areas such as manufacturing, mining, oil and gas, water and waste management, power generation and energy, as well in pharmaceutical field. The graduates can be employed as Control and Instrumentation Technician, Instrumentation Technician, Instrumentation Supervisor, Project Technician, Project Manager.

REVIEW PERIOD

The qualification will be reviewed every five (5) years or as and when required depending on the changing needs of the market**.**