SECTION A: QUALIFICATION DETAILS

QUALIFICATION DEVELOPER (S)	New Era College of Arts, Science and Technology				
TITLE	Diploma In Mechanical Engineering			***NCQF LEVEL***	*6*
FIELD	Manufacturing Engineering and Technology	***SUB-FIELD***	Mechanical Engineering	***CREDIT VALUE***	*370*
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

The development of the qualification in Mechanical Engineering (General) was guided by the Education and Training Sector Strategic Plan, ETSSP, (2015-2020) for the provision of quality and relevant education. The ETSSP was aimed at reforming the education system and addressing issues of poor performance in the sector, National Development Plan 11, NDP11, (2017 -2023, Page 118). The Human Resource Development Council, HRDC, (2016-2021, Page 119), through the 14 HRDC Sector Committees which were established to address the problem of skills mismatch for a globally competitive Human Resource. Vision 2036 was launched, which focused on "achieving prosperity for all", under Pillar 2, *Human and Social Development* for education and skills development. It ensured that Botswana society will be knowledge based with relevant quality education that is outcome based, emphasizing on education with production, Vision, (2036, Page 31). Furthermore, Statistics Botswana through its data portal led the 2030 agenda for sustainable development and refined its mandate through sustainable development goals. Goal number 4 was aimed at leading quality education to ensure

inclusive and equitable quality education and promote lifelong learning opportunities for all, (http://botswana.opendataforafrica.org). In tandem with the above, Botswana Qualifications Authority (BQA) in consultation with HRDC Sector Committees developed fields that every qualification developed in the economy of Botswana should meet the sector supply and demands. The Qualification Developer in its quest, developed a robust home-grown qualification that meets the demands of the niche market. The qualification has unique modules that are relevant in ensuring unique skills for Higher Education.

Mechanical Engineering is regarded as one of the scarce skills in Botswana. BQA advocated for Private Institutions to develop their own home-grown Qualification that meet with the demand and relevance of the local industry. The Qualification Developer realised the niche market for Mechanical Engineering. The Department of Curriculum Design and Development developed a robust home-grown Diploma in Mechanical Engineering (General) that meets with the national and economical needs of Botswana.

The Qualification Developer conducted an extensive market survey prior to the designing of the qualification where critical gaps in the Mechanical Engineering Industry, Commerce and other service organizational training were identified. The critical gaps were related the mismatch in the employability of the students in Mechanical Engineering industry. At the breakfast meeting, the market was concerned about the lack of Computer Aided Manufacturing skills. This qualification is infused with modules that develop skills in Thermodynamics, Manufacturing Engineering, Thermal Engineering and Theory of Machines. The Market survey was conducted on the Mechanical Engineering Firms in Botswana and Government Departments who needed extensive Mechanical Engineering skills. The Breakfast Meeting revealed that most Mechanical Engineering firms expect the graduate to be articulate in the application of Engineering software.

PURPOSE:

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

- Complete all work in compliance with current legislation, standards, regulations and guidelines.
- Apply quality control and quality assurance procedures to meet organizational standards and requirements.
- Comply with current health and safety legislation, as well as organizational practices and procedures.
- Apply sustainability best practices in workplaces.
- Use current and emerging technologies to support the implementation of mechanical engineering projects.
- Analyse and solve mechanical problems by applying mathematics and fundamentals of mechanical engineering.
- Interpret, prepare and modify mechanical engineering drawings and other related technical documents.
- Contribute to the design and the analysis of mechanical components, processes and systems applying fundamentals of mechanical engineering.

- Manufacture, assemble, maintain and repair mechanical components according to required specifications.
- Verify the specifications of materials, processes and operations to support the design and production of mechanical components.
- Contribute to the planning, implementation and evaluation of projects.
- Develop strategies for ongoing personal and professional development to enhance work performance

ENTRY REQUIREMENTS (including access and inclusion)

Minimum entry requirement:

- Certificate IV, NCQF Level 4 (General Education or TVET) or equivalent with passes in 6 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 SPECIFICATIONS

GRADUATE PROFILE (LEARNING OUTCOMES)	ASSESSMENT CRITERIA
1. Demonstrate knowledge in the professional background and regulations of mechanical engineering.	• Explain the fundamental mechanical sciences – Strength of materials, dynamics, fluid dynamics, thermodynamics, manufacturing and Industrial safety. • Describe clearly the latest capabilities of mechanical engineering. • Carry out effectively mechanical engineering projects. • Communicate more effectively as mechanical engineers. • Outline the key elements of mechanical engineering. • State the different levels of professional engineers and the different skills. • Outline an overview of mechanical engineering design - Process and principles

	• Validate the specifications of materials, processes and operations to support the design and production of mechanical components. • Develop strategies for on-going personal and professional development to enhance work performance.
2. Engage in workshop practices and develop skills in grinding, cutting and welding of materials.	• Exercise safety procedures and regulations. • Select appropriate tools and perform machining operations. • Carry out welding process selection. • Select and apply methodologies of quality control and inspection of welded joints.
3. Demonstrate applied engineering mechanics including kinematics, dynamics, statics and hydraulics.	• Examine a mechanical system and derive all forces, couples and moments about it • Solve linear velocity and friction problems • Evaluate hydrostatic problems related to ship's systems • Describe the different energies stored in a liquid.
4. Utilise appropriate manufacturing engineering methods and tools to improve engineering systems.	• Apply mathematics, science, and engineering to solve engineering problems. • Design and conduct experiments, as well as to analyse and interpret data. • Identify, formulates, and solves engineering problems. • Use the techniques, skills, and modern engineering tools necessary for engineering practice. • Explain the behaviour and properties of materials as they are altered and influenced by processing in manufacturing. • Control manufacturing operations using statistical and calculus-based methods, simulation and information technology.
5. Calculate derivations of basic equations of fluid mechanics in order to derive basic equations and the related assumptions.	• Solve hydrostatic problems. • Describe the physical properties of a fluid. • Calculate the pressure distribution for incompressible fluids.

	• Calculate the hydrostatic pressure and force on plane and curved surfaces. • Demonstrate the application point of hydrostatic forces on plane and curved surfaces. • Formulate the problems on buoyancy and solve them. • Describe the principles of motion for fluids. • Describe the areas of velocity and acceleration. • Formulate the motion of fluid element. • Apply the equation of the conservation of momentum apply the equation of the conservation of energy. • Make dimensional analysis and similitude. • Use the dimensional analysis and derive the dimensionless numbers apply the similitude concept and set up the relation between a model and a prototype.
6. Apply Thermodynamics skills in industrial works.	• Calculate absolute and gage pressure, and absolute temperature. • Calculate changes in kinetic, potential, enthalpy and internal energy. • Evaluate the properties of pure substances • Evaluate the state of the pure substances such as compressed liquid, saturated liquid-vapour mixture and superheated vapour using property diagrams and tables. • Formulate the first law of thermodynamics for closed systems and arrange the change in energy in the closed systems via heat and work transfer. • Distinguish heat transfer by conduction, convection and radiation and calculated the amount of heat energy transferred. • Calculate the changes in moving boundary work, spring work, electrical work and shaft work in closed systems. • Apply first law of thermodynamics for closed systems and construct conservation of mass and energy equations. • Apply the first law of thermodynamics to the open systems.

	• Describe steady-flow open system. • Apply the first law of thermodynamics to the nozzles, diffusers, turbines, compressors, throttling valves, mixing chambers, heat exchangers, pipe and duct flow • Arrange first law of thermodynamic for chemical reaction using enthalpy of formation and combustion and calculate adiabatic flame temperature.
7. Design using computer aided design (CAD) applications.	• Explain that the computer is not only a visualization tool but also a tool for design. • Explain how computer aided design concept add efficiency and speed to the Works. • Work with 3D in the virtual environment. • State the differences in scale between the unlimited and virtual environment of computer and physical environment. • Alter the objects created in virtual environment. • Control 3Ds Max/Pro E/ Solid works Program on the solid modelling in 3Ds Max. • Control Standard parities by the help of modifiers in 3Ds Max to make polygonal modelling in 3Ds Max/ Pro E/ Solid Works. • Create materials and assign them in 3Ds Max may transfer files between 3Ds Max and other programs may produce realistic images via 3Ds Max program may create interior design in 3Ds Max.
8. Prepare a project in Mechanical Engineering.	• Get guidance from the supervisor on the project to be done. • Select the type of project relating to Mechanical Engineering using design and production. • Prepare clear research report stating the aims and objectives using design and other criteria under supervision. • Prepare the research project schedule • Investigate the problems • Assess the result deciding further work necessary to carry the problems to logical conclusion.

	• Develop costing and estimating models in Mechanical Engineering. • Relate the aims, objectives, design and criteria. • Assemble the design and frame where necessary. • Draw up conclusion. • Type the report to an acceptable standard. • Present the research report under the supervision to accredited audience.
9. Consolidate the theory and practice through attachment within the mechanical engineering field.	• Apply practical knowledge and skills in Mechanical Engineering. • Produce placement report detailing work done and skills acquired. • Present on their placement experience. • Keep a detailed log-book of work done, with workplace. Supervisor approvals. • Get a consolidated attachment report for the whole session.

SECTION C	***QUALIFICATION STRUCTURE***			
COMPONENT	***TITLE***	***Credits Per Relevant NCQF Level***		***Total (Per** Subject/ Course/ Module/ Units)*
		Level [5]	***Level [6]***	***Credits***
FUNDAMENTAL COMPONENT	Engineering Mathematics - I	10		10
	Engineering Science – I	10		10

Subjects/ Courses/ Modules/Units	Professional Practice and Communication Skills	10		10
	Information and Computing Skills	15		15
	Engineering Mathematics – II		10	10
	Engineering Science – II		10	10
CORE COMPONENT *Subjects/Courses/ Modules/Units*	Mechanical Engineering Workshop Practice		15	15
	Electrical and Electronics Workshop		15	15
	Engineering Drawing – I	15		15
	Material Science and Metrology		10	10
	Manufacturing Engineering – I		15	15
	Electricity and Magnetism	10		10
	Strength of Materials		10	10
	Engineering Drawing – II		15	15
	Introduction to Programming Principles	15		15
	Thermodynamics		10	10
	Refrigeration and Air Conditioning		10	10
	Manufacturing Engineering – II		15	15
	Fluid Dynamics and Pneumatics		15	15
	Theory of Machines		10	10

	Industrial Attachment		50	50
	Individual Project		30	30
	Industrial Safety and Maintenance		10	10
	CAD/CAM		15	15
ELECTIVE/ OPTIONAL COMPONENT *Subjects/Courses/ Modules/Units*	**Set 1 (choose 1)** Production Planning and Control Power Plant Engineering Industrial Engineering and Management		10	10
	Set 2 (choose 1) Automobile Technology Design of Machine Elements Alternate Energy Sources and Management		10	10
	Total Credits			**370**

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SUMMARY OF CREDIT DISTRIBUTION FOR EACH COMPONENT PER NCQF LEVEL	
TOTAL CREDITS PER NCQF LEVEL	
NCQF Level	***Credit Value***
Level 5	85
Level 6	285
TOTAL CREDITS	**370**

RULES OF COMBINATION:

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

In order for the qualification to be awarded the qualifying graduate must have acquired the following credits:

Credit Distribution

No	***Component***	***Modules***	***Credits***
1	*Fundamental Component*	*6*	*65*
2	*Core Component*	*16*	*205*
3	*Individual Project*	*1*	*30*
4	*Industrial Attachment*	*1*	*50*
5	*Elective Component Choose 2 Modules*	*2*	*20*
4	***Total***	***26***	***370***

Level Credit Distribution

No	**Component**	**Credits**
1	Level 5	85
2	Level 6	285
3	**Total**	**370**

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.

Assessment arrangements will be done 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 qualifications. Both internal and external moderation shall be done in accordance with applicable policies and regulations.

RECOGNITION OF PRIOR LEARNING

Recognition of Prior Learning (RPL) is related to prospective students who had on-the-job Training and assessed by the employer's Human Resources Training and in consultation with Botswana Engineers Registration Board (BERB) to confirm competence and Notional learning Hours gained during the Experiential Period. The Institution would use Evaluation Form to convert the accumulated hours into credits related to the areas covered with equivalence to the modules in the qualification and determine the entry level.

CREDIT ACCUMULATION AND TRANSFER

Credit Accumulation and Transfer CAT policies which is in line with National Policies.

PROGRESSION PATHWAYS (LEARNING AND EMPLOYMENT)

HORIZONTAL PATHWAY

Graduates of this qualification may consider pursuing related qualification for the purpose of multiskilling, retooling and gain expert knowledge in the Mechanical Engineering field.

- Diploma in Mechanical and Fluid Engineering.
- Diploma in Mechanical and Automotive Engineering.
- Diploma in Mechatronics

VERTICAL PATHWAY

Graduates may progress to qualifications such as:

- Bachelor's in mechanical and Fluid Engineering.

- Bachelor of Science in Mechanical and Automotive Engineering.
- Bachelor of Science in Mechatronics.

EMPLOYMENT PATHWAYS

Graduates from the Diploma in Mechanical Engineering (General) will have requisite competencies and attributes to work as:

- Mechanical technician.
- Production Supervisor.
- Senior manufacturing technician.
- Quality Manager.
- Plant Manager.
- Project technician.
- Machine Designer.
- Senior Mechanical technician.
- Field Service technician.
- Mechanical Product Development technician

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

QUALIFICATION AWARD AND CERTIFICATION

Minimum Standard of achievement for the award of the qualification.

To be awarded the qualification the graduate, must complete minimum of 65 Credits of the Fundamental Component, 285 Credits of the Core component and 20 Credits for the Elective Component which makes a total of **370** credits.

Certification

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

REGIONAL AND INTERNATIONAL COMPARABILITY

1. Zambia University of Science and Technology, Diploma in Mechanical Engineering, NCQF level 6, (305 Credits), Prepare Students for the increasing demands of designing and producing more complex

mechanical devices to serve the needs of the organizations enabling them to make a key leadership contribution to their chosen fields.

2. Namibia University of Science and Technology, Diploma in Mechanical Engineering, NCQF Level 6, (350 Credits), The program expects graduates to demonstrate the ability to analyse, design and improve practical thermal and/or mechanical systems effectively and work well on team-based engineering projects and pursued continued professional development, including professional registration if desired.

3. Clausthal University of Technology (Germany), Diploma in Mechanical Engineering, NCQF Level 6, with 250 Credits provides the programme that focuses on Mechanical Engineering as two interrelated areas of study intended to develop human capital for the Mechanical Engineering by exposing learners to an up-to-date Mechanical Engineering curriculum and students go for attachment in the Mechanical Engineering Companies for real life situations in Engineering Industry.

4. Engineering Institute of Technology (Australia), Diploma in Mechanical Engineering, NCQF Level 6, with 260 Credits, encompasses the conceptualisation, design, manufacture, control and maintenance of machines ranging from a conveyer, space shuttle to nanotechnology based objects. In broad terms, mechanical engineering channels the energy and forces in nature to the service of people. The fields in which mechanical engineering professionals operate are wide - ranging from oil and gas, power generation, water utilities, process plants, mining, pharmaceuticals, manufacturing and defence.

5. Other Qualifications offered in countries such as New Zealand and United States of America generally emphasis on development of competencies in local and global Mechanical Engineering and how these can be synthesized to bring the best of Mechanical Engineering. Market trends signify that Mechanical Engineering has high skills demand; labour market Observatory confirms the same through HRDC Sector committees on Occupations on demand. Although the qualifications examined generally follow similar structures and standards, there are differences, though not significant, in that their niche

market and qualification layout are focusing in certain sectors of the economy which is different from the other.

Similarities

- All qualification uses the title Diploma in Mechanical Engineering implying commonality to intent and purpose of the qualification from the title of the qualification
- All qualifications consider main domain knowledge, competencies and skills as centred on core areas manufacturing, design engineering and maintenance engineering.
- All qualifications consider industrial experience or internship as important before graduation
- All qualifications consider dissertation or research as critical for skill acquisition to outright skills in mechanical engineering
- All qualifications consider emerging technologies in mechanical engineering and use of science and mathematical in masterminding mechanical engineering
- All qualifications tone down on the same employment pathways

Differences

- The total credits awarded at the completion of the qualification are different because of the different credit framework used
- Some qualifications are eligible for professional qualification upon completion of the study with the engineering body of the that country
- The program duration is different compared with the benchmarked institutions

The proposed qualification generally compares well with all the qualifications studied since the exit outcomes cover similar scope and depth and are aligned to exit-level descriptors typical to this level and type of qualification as done within the region and beyond as well as competencies required for registration and accreditation with professional bodies such as Engineers Registration of Botswana (ERB). However, what sets it apart from the other qualifications examined is that there is provision for development of attributes such as Mechanical Engineering, Structural Engineering, Drive Systems, Hydraulics, Pneumatics and Energy Efficiency which are crucial for the Mechanical Engineering. The programme for Qualification Developers outcome based and is anchored on a competency and credit-based qualification framework.

The qualification is contextualised by benchmarking the areas stated above and as follows

- The National Qualification Level shall be BQA NCQF Level 6 in Mechanical Engineering (General) focus on Manufacturing engineering, Design engineering, and Maintenance engineering and baseline on science, mathematics, computer and electronics/electrical knowledge
- The qualification also ensures registration of graduates with the local engineering board ERB upon completion of the study as Engineer Technician.
- The qualifications Mechanical Engineering (General) adopted elective as means of co-opting specialization according to a majority of the universities.
- The qualification puts emphasis on professional practice to build competency through internship attachment, and practice.

Generalisation

The qualification based on the similarities and minor differences determined it is portable and generalizable within the international Universities

REVIEW PERIOD

The qualification will be reviewed after 5 years