QUALIFICATION SPECIFICATION							
							SECTION A
QUALIFICATION DEVELOPER	Botswana International University of Science and Technology						
TITLE	Bachelor of Engineering Honours in Mechanical and Energy Engineering				**NCQF LEVEL**	8	
FIELD	Manufacturing Engineering and Technology		**SUB-FIELD**	Mechanical and Energy Engineering			
New qualification	✓	Review of existing qualification					
SUB-FRAMEWORK	General Education		TVET		Higher Education	✓	
QUALIFICATION TYPE	Certificate		Diploma		Bachelor		
	Bachelor Hons	✓	Master		Doctorate/ PhD		
CREDIT VALUE					**654**		

RATIONALE AND PURPOSE OF THE QUALIFICATION

RATIONALE

The national human resource development plan developed by the Human Resource Development Council (HRDC) indicates that Mechanical and Energy Engineering is one of the core/ critical professional business requirements in the country. The Mining, Minerals, Energy & Water Resources sector is arguably the major contributor to the country's economy for many decades. Employment opportunities continue to grow for Mechanical and Energy Engineers as their professional skills are transferable across the sub-sectors of the economy. The ease of transferability of mechanical and energy skills provides a great opportunity to find work anywhere in the world. Mechanical and Energy engineers are required in the design, installation, operation and maintenance of plants. Also most industries employ manufacturing plants, machineries, fuels and heat in the delivery of their products and services. Mechanical and Energy engineers will continue to find employment in the vast industry, commerce, public service and research to solve major

challenges in sustainable energy provision, the development of innovative devices and new materials for various products and artifacts.

Present studies has shown that the world is moving from a traditionally product driven market to a services market. This phenomenon then present distinctive requisite in terms of the analysis and design of systems. Traditional engineering specialists have difficulty in transferring product skills to system skills without considerable experience. Recent market research have also shown that there are huge shortage for engineers with specialist skills in the design, development, analysis and optimization of processes as it pertains to the services industry within Botswana and the world in general. It is against this background that a qualification in Mechanical & Energy Engineering is proposed to address the rising demand in inter-disciplinary engineers.

A graduate of this programme would be competent in both the fundamental principles of mechanical engineering and energy engineering. The Bachelor of Engineering (B.Eng.) qualification in mechanical and energy engineering is proposed to have a strong focus on plants, systems and processes, renewable energy technologies, advanced energy systems so as to ensure that graduates are adequately exposed to the concepts, tools, and techniques that will be required to effectively function as mechanical and energy engineers within the Botswana economy, SADC and internationally. Labour surveys conducted by the World Bank also found that at least 50% of manufacturing firms in Botswana find it extremely difficult to find engineering graduates with appropriate skills in managing different organisations. Hence, the government of Botswana through NDP10 mandated universities to produce people with those required skills. Therefore, the B. Eng. curriculum in mechanical and energy is aligned to the 10th national development plan (NDP 10), NDP 11 and vision 2036 which aim to engage training in modern and environmentally friendly processes in developing a critical mass of engineers required to achieve Botswana's vision of transformation to a knowledge-based economy.

PURPOSE OF QUALIFICATION

The purpose of this qualification is to produce industry–ready Mechanical and Energy Engineering graduates with highly specialized knowledge, skills and competences to:

- Apply knowledge acquired in mathematics, basic sciences, engineering sciences, engineering simulation, modelling and design in solving real life problems.
- Develop inter-disciplinary research, innovate, design and build engineering systems for national development.
- Apply information technology related skills in their specific work areas.
- Communicate, report, and interact with their work communities and professional audiences.
- Implement and develop safety, health, environmental, and quality (SHEQ) protocols and procedures within the Mechanical and Energy industries.

ENTRY REQUIREMENTS (including access and inclusion)

- The minimum entry requirement is Certificate IV NCQF Level 4 (Botswana General Certificate of Secondary Education, BGCSE) or its equivalent with passes in Mathematics, Physics, Chemistry and English Language).
- Recognition Prior Learning (RPL) and Credit Accumulation and Transfer (CAT) will be considered for entry to this qualification for applicants who do not meet the minimum entry requirement

QUALIFICATION SPECIFICATION
SECTION B

GRADUATE PROFILE (LEARNING OUTCOMES)	ASSESSMENT CRITERIA
1. Apply a range of highly specialised engineering principles to systematically diagnose and solve complex Mechanical and Energy Engineering problems	1.1 Analyses and defines the problem, identifies the criteria for an acceptable solution. 1.2 Identifies necessary information and applicable engineering and other knowledge and skills. 1.3 Generates and formulates possible approaches to solution of problem. 1.4 Models and analyses possible solution(s);

	1.5 Evaluates possible solutions and selects best solution; 1.6 Formulates and presents the solution in an appropriate form
2. Apply highly specialised knowledge of mathematics, natural science and engineering sciences to define and apply Mechanical and Energy Engineering procedures, processes, systems and methodologies to solve complex problems**.**	2.1 Integrate principles of mathematics, numerical analysis and statistical knowledge and methods, Thermodynamics, Fluid Dynamics and Materials Sciences to solve Mechanical and Energy Engineering problems. 2.2 Develop processes and or procedures to produce components and products for various industrial specification and national development, especially in Mechanical and Energy related industries.
3. Perform creative, procedural and non-procedural design and synthesis of complex Mechanical and Energy Engineering components, systems, works, products or processes to meet desired needs normally within applicable standards, codes of practice and legislation.	3.1 Identifies and formulates the design problem to satisfy user needs, applicable standards, codes of practice and legislation; 3.2 Plans and manages the design process: focuses on important issues, recognizes and deals with constraints; 3.3 Acquires and evaluates the requisite knowledge, information and resources: applies correct principles, evaluates and uses design tools; 3.4 Performs design tasks including analysis, quantitative modelling and optimization; 3.5 Evaluates alternatives and preferred solution: exercises judgment, tests

	implementability and performs techno-economic analyses; 3.6 Assesses impacts and benefits of the design: social, legal, health, safety, and environmental; 3.7 Communicates the design logic and information
4. Design and conduct investigations and experiments.	4.1 Plans and conducts investigations and experiments; 4.2 Conducts a literature search and critically evaluates material; 4.3 Performs necessary analyses; 4.4 Selects and uses appropriate equipment or software; 4.5 Analyses, interprets and derives information from data; 4.6 Draws conclusions based on evidence; 4.7 Communicates the purpose, process and outcomes in a technical report
5. Apply appropriate engineering methods, skills and tools, including those based on information technology.	5.1 Select appropriate techniques, resources, and modern engineering tools (engineering software) to solve industry related problems 5.2 Understand the constraints of using different engineering application packages, when solving an industry related problem.

	5.3 Use appropriate software to predict and model complex Mechanical and Energy Engineering problems.
6. Communicate effectively, both orally and in writing, with engineering audiences and the community at large.	6.1 Use oral and written communication effectively with engineering audiences and stakeholders. 6.2 Report results obtained from procedural work, research, and design projects in a professional manner. 6.3 Explain accurately the impact of engineering activities/processes to relevant stakeholders.
7. Evaluate and demonstrate critical awareness of the impact of engineering activity on the social, industrial and physical environment.	7.1 Monitor industrial processes on the society and environment. 7.2 Identify the impact of industrial processes on society and environment. 7.3 Evaluate the environmental and socio-economic factors of Mechanical and Energy Engineering processes. 7.4 Use engineering and scientific tools to solve Mechanical and Energy Engineering processes
8. Demonstrate advanced and specialised knowledge and understanding of Mechanical and Energy Engineering management principles and apply these to one's own work, as a member and leader in a team and to manage projects.	8.1 Implement quality planning in project management. 8.2 Apply risk and value management in decision making. 8.3 Demonstrate good leadership (e.g. delegation and coordination) in project planning and execution.

	8.4 Work as a member of a team and or lead a team in planning and executing individual and or group project(s). 8.5 Take responsibility and accountability in the tasks/project as a team member/team leader
9. Demonstrate mastery to engage in independent and life-long learning through well-developed learning skills.	9.1 Work independently on project to achieve a desired objective. 9.2 Show competency when executing assigned industrial task(s). 9.3 Exercise autonomy, initiative an0d authority in planning and executing project(s).
10. Apply ethical principles and commit to professional ethics, responsibilities, and norms of engineering technology practice	10.1 Adhere to ethical principles and professional practice, responsibilities, and norms of engineering practice in executing projects. 10.2 Observe social responsibilities when executing project(s). 10.3 Uphold professional integrity in an impartial manner.
11. Apply engineering management principles and economic decision-making	11.1 Perform cost estimation for project(s). 11.2 Implement cost optimization in decision-making process.

QUALIFICATION STRUCTURE SECTION C			
FUNDAMENTAL COMPONENT Subjects / Units / Modules /Courses	**Title**	**Level**	**Credits**
	Fundamental Components		**114**
	Pre-calculus	5	12
	General Chemistry 1	5	12
	Introductory Physics 1	5	12
	Introduction to Technical Communication and Academic Literacy	5	6
	Introduction to Computing	5	12
	General Chemistry II	5	12
	Introductory Calculus	5	12
	Introductory Physics II	5	12
	Introductory to Statistics	5	12
	Procedural Programming	5	12
			174
FUNDAMENTAL COMPONENT Subjects / Units / Modules /Courses	Introduction to Engineering	5	6
	Workshop Practice	5	12
	Engineering Graphics	5	12
	Engineering Mathematics I	5	12
	Strength of Materials	5	12
	Engineering Mechanics II –(Dynamics)	5	12
	Object-Oriented Programming	5	12
	Fundamentals of Electrical Engineering II	5	12
	Design Methods	5	6
	Engineering Mathematics II	5	12
	Technical and Professional Communication	6	6
	Engineering Mechanics I – (Statics)	5	12
	Fluid Mechanics I	6	12
	Thermodynamics I	6	12

	Material Science	5	12
	Fundamentals of Electrical Engineering I	5	12
CORE COMPONENT Subjects / Units / Modules /Courses	**CORE COMPONENT**		**336**
	Engineering Mathematics III	6	12
	Research Methods for Engineering and Technology	6	12
	Fluid Mechanics II	6	12
	Thermodynamics II	6	12
	Theory of Machines & Mechanisms	6	12
	Technical and Professional Communication	6	6
	Measurements & Instrumentation	6	12
	Engineering Project Management	6	12
	Engineering Mathematics IV	6	12
	Linear Control Systems	7	12
	Heat & Mass Transfer	7	12
	Energy Efficiency & Management	7	12
	Manufacturing Technology II (Elective)	7	12
	Electrical Energy Systems (Elective)	7	12
	Economics, Business & Entrepreneurship	7	12
	Energy Conversion Processes	7	12
	Industrial Training	7	36
	Starting and Sustaining a Business	7	6
	Management & Entrepreneurship: Concept & Principles	7	6
	Mechanical, Energy and Industrial Engineering Design Project I	8	12
	Professional Practices & Ethics	8	12
	Developing a Strategic Business Plan	8	6
	Reliability & Maintenance Engineering	8	12
	Mechanical, Energy and Industrial Engineering Design Project II	8	24
	Solar Energy Engineering	8	12

	Design of Thermal Systems	8	12
	Engineering Business & Society	8	12
ELECTIVE COMPONENT Subjects / Units / Modules /Courses	**ELECTIVE COMPONENT**		**36**
	Renewable Energy Technologies	8	12
	Manufacturing Technology I	8	12
	Fuel Science & Combustion	8	12
	Design of Machine Elements	8	12
	Refrigeration & Air Conditioning	8	12
	Technology & Innovation Management	8	12
	Energy Efficiency Buildings	8	12
	Hydro & Wind Energy	8	12
	Mechanical Behaviour of Materials	8	12
	Finite Element Analysis for Engineers	8	12
	Fatigue &Failure Analysis	8	12
	Tribology	8	12
	Biofuel Technology	8	12
	Smart Grids & Distributed Power	8	12
	Advanced Energy Systems	8	12
	Air Pollutant from Combustion Processes	8	12

RULES OF COMBINATIONS, CREDIT DISTRIBUTION (where applicable):

Fundamental	294 Credits
Core	324 Credits
Electives	36 Credits (Learners choose 3 modules)
Total	654 Credits

ASSESSMENT AND MODERATION ARRANGEMENTS

All assessments, formative and summative, research and others (mostly work integrated learning) leading/contributing to the award of credits or a qualification should be based on learning outcomes and/or sub-outcomes. The qualification assessments are based on the following:

Coursework/Formative/CA	Summative	Research	Others
34%	51%	9%	5%

MODERATION

This qualification will be moderated both internally and externally as per ETP policy in line with national policies.

RECOGNITION OF PRIOR LEARNING (if applicable)

RPL and CAT will be considered for the award of this qualification

PROGRESSION PATHWAYS (LEARNING AND EMPLOYMENT)

LEARNING PATHWAYS

Horizontal articulation

- Postgraduate Diploma in Mechanical and Energy Engineering.
- Postgraduate Diploma in Mechanical Engineering.
- Postgraduate Diploma in Engineering Management.

Vertical articulation

- Master of Engineering in Mechanical and Energy Engineering.
- Master of Engineering in Mechanical Engineering.
- Master of Engineering in Energy Engineering.

EMPLOYMENT PATHWAYS

Graduates from this qualification can apply to register as candidate engineers with relevant professional bodies and can be employed in a number of industries (e.g. Auto mobile, Aerospace, Marin (ship yard), Renewable energy plants, Power generation plants, Education, Research & Development, fabrication and processing industries, etc.) in the following positions:

- Maintenance Engineer
- Plant design Engineer
- Energy Engineer
- Welding engineer
- Quality control supervisor
- Process Control Engine
- Simulation Engineer
- Failure Analysis Consultant
- Plant operator supervisor
- Materials Consultants
- Marketing engineer
- Researchers

QUALIFICATION AWARD AND CERTIFICATION

Minimum standards of achievement for the award of the qualification

A candidate is required to achieve the minimum stipulated total credits of **654** credits in order to be awarded Bachelor of Engineering in Mechanical and Energy Engineering. The candidate must also attain and fulfill all the rules of combination required for this qualification.

Certification

Candidates meeting prescribed requirements will be awarded the certificate in accordance with standards prescribed for the award of the qualification and applicable policies. Candidates who do not meet the prescribed minimum standards may, where applicable, be considered for appropriate exit awards in accordance with applicable policies.

REGIONAL AND INTERNATIONAL COMPARABILITY

This qualification was benchmarked with three qualifications from universities in different region of the world being as follows:

- B Eng (Mechanical Engineering) Stellenbosch University South Africa
- BSc (Mechanical & Energy Engineering) Texas USA.
- BEng (Mechanical Engineering (Power & Energy) University of Lincoln USA.

The comparability standard of Bachelor of Engineering (Mechanical and Energy) degree is viewed from the basis of the accreditation bodies. ABET (USA), IMechE (UK) and ECSA (South Africa) all subscribes to the Washington Accord. It is on this ground that we view the standards of this degree as comparable with those traditionally specialized qualification in engineering offered in countries where Washington Accord are also used as a standard. Comparability index is audited every six years by visiting accrediting body.

REVIEW PERIOD

This qualification shall be reviewed every five years.