QUALIFICATION SPECIFICATION							SECTION A
QUALIFICATION DEVELOPER	Botswana University of Agriculture and Natural Resources (BUAN)						
TITLE	Bachelor of Science in Biomathematics				**NCQF LEVEL**	7	
FIELD	Natural, Mathematical and Life Sciences		**SUB-FIELD**	Biomathematics			
New qualification	√	Review of existing qualification					
SUB-FRAMEWORK	General Education		TVET		Higher Education	√	
QUALIFICATION TYPE	Certificate		Diploma		Bachelor	√	
	Bachelor Honours		Master		Doctor		
CREDIT VALUE					520		

RATIONALE AND PURPOSE OF THE QUALIFICATION

Rationale

The BSc Biomathematics qualification was developed in line with the Human Resources Development Council Top Occupations in Demand, 2016 which identified the need for mathematicians, actuaries, statisticians, econometricians and agricultural scientists in the labour market (short term) as well as opportunities for employment growth (long term). In addition, the Basic Sciences department conducted a needs assessment survey in 2012 in which stakeholders indicated a need for the development of a Biomathematics academic qualification. Also, the Vision 2036 and NDP 11 highlighted the necessity to transform the Botswana economy to a knowledge-based economy driven by science, research, innovation and technology.

A qualification of Biomathematics is very critical in that it supports the development of research, innovation and technology, and in particular advancing the science, technology, engineering and mathematics (STEM) goals, thus, driving the country towards being a knowledge-based economy. Following the above, a qualification in Biomathematics will empower the graduates for employment in government agencies, education and private business.

Purpose of the Qualification

The purpose of the Bachelor of Science in Biomathematics is to:

i. Develop qualified and relevant manpower with an advanced understanding of the principles and concepts of Biomathematics and its applications.
ii. Equip graduates with skills to plan and execute research and critically evaluate the results and formulate relevant evidence-based models.
iii. Develop graduates who can effectively communicate information and ideas to different stakeholders.

iv.	Equip graduates to operate at an advanced level in their assignments by exercising responsibility and accountability for achieving the desired team and individual outcomes.

ENTRY REQUIREMENTS (including access and inclusion)

Entry into this qualification is through any of the following:

- Certificate IV, NCQF Level 4 (e.g. BGCSE) with a minimum pass in the following subjects: Biology, Chemistry, Physics, Mathematics and English Language.
- There will be access through Recognition of Prior Learning (RPL) and Credit Accumulation and Transfer (CAT) in accordance with the RPL and CAT National Policies.

QUALIFICATION SPECIFICATION SECTION B

GRADUATE PROFILE (LEARNING OUTCOMES)	ASSESSMENT CRITERIA
Holders of this qualification should be able to: 1. Apply mathematical knowledge of professional practice and good work ethics	i. Demonstrate procedural and computational understanding of mathematics. ii. Master proof techniques in various mathematical theories. iii. Demonstrate proficiency in applying mathematical theories to solve applied problems in various areas. iv. Formulate conjectures, produce new mathematical knowledge, and conduct supervised original research in one of the areas of mathematics or its applications. v. Identify the central ethical problems, affected parties and their interest. vi. Set possible solutions for the problems. vii. Evaluate each solution using the interest of those involved by according them suitable priority. viii. Select and justify the solution that best solves the problem.
2. Integrate mathematical knowledge towards entrepreneurship, innovation, creativity, and experiential learning.	i. Apply basic principles of entrepreneurship as a tool for development, financial sources for startups and modes of business networks ii. Develop novel and useful ideas that transform and create new markets.

	iii. Apply creative ideas to produce unique and transformative new products and services. iv. Raise awareness of creativity and its importance for society and for personal development. v. Increase understanding of the nature of creativity, creative persons, common barriers to creative thinking, and the creative process. vi. Present techniques for creative thinking. vii. Put new knowledge, skills and abilities, and attitudes into practice in everyday life.
3. Apply critical thinking and problem-solving techniques.	i. Apply and integrate scientific knowledge to solve theoretical, applied and real-life problems. ii. Demonstrate the ability to reflect on the importance of scientific paradigms and methods to understand scientific concepts and their changing nature iii. Demonstrate understanding of boundaries, inter-connections, value and knowledge creation or innovation of mathematics within sciences iv. Develop and adapt appropriate algorithms to solve problems, test hypothesis, and formulate predictions. v. Apply mathematical logic and problem-solving skills to study data. vi. Define and explain appropriate techniques to process data and derive logical conclusions. vii. Solve problems and visualize information in mathematics using graphing calculators and spreadsheets. viii. Interpret and critically evaluate qualitative and quantitative results in the context of the original problem and make recommendations.
4. Demonstrate team building, leadership and supervisory skills.	i. Demonstrate the ability to conduct oneself as an independent learner and practitioner. ii. Foster creativity and innovation while empowering growth and collaboration through classroom and accountable community foundations

	iii. Effectively work in a multi-disciplinary environment. iv. Accept comments and feedback and learn from them. v. Explain fundamental mathematical or statistical concepts to non-experts. vi. Justify choices made during problem solving and interpretation of results.
5. Demonstrate the ability to collect, process, assess and communicate information.	i. Present, examine, summarize, and evaluate presentations given by another individual or group. ii. Present original work and new mathematical results in appropriate settings such as a class, seminar, professional meeting or publication. iii. Apply symbolic software, graphing calculators and spreadsheets to present, visualize, model and interpret results. iv. Analyze problems in mathematics using dynamic geometry software, programming languages, and symbolic mathematical and analytical software.
6. Apply basic research skills, critical analysis and independent evaluation.	i. Construct, evaluate, and revise complex problems to determine relevant mathematical principles and available software and hardware to solve problems. ii. Identify basic arithmetic and algebraic manipulation skills to interpret fairly simple statistical problems using textual write-ups, lines, charts, graphs and tables. iii. Apply mathematical logic and problem-solving skills to study data. Define and explain appropriate techniques to process data and derive logical conclusions. iv. Identify practical applications of statistics, including data sets with significant variation.
7. Demonstrate autonomy, initiative, authority, responsibility and accountability.	i. Demonstrate mastery of professional practice in the field of mathematics. ii. Demonstrate ability to manage functions and processes. iii. Demonstrate capacity to carry out basic research, critical evaluation and synthesis of ideas, issues and concepts.

	iv. Demonstrate capability to identify and solve complex and unpredictable problems.

QUALIFICATION STRUCTURE			**SECTION C**
FUNDAMENTAL COMPONENT Subjects / Units / Modules /Courses	**Title**	**Level**	**Credits**
	Mathematics I	5	12
	General and Inorganic Chemistry	5	12
	Physics I	5	12
	Biology of Cells	5	12
	Computer Skills Fundamentals I	6	8
	Communication and Academic Literacy Skills I	6	12
	Mathematics II	5	12
	Physical and Organic Chemistry	5	12
	Physics II	5	12
	Biodiversity	5	12
	Computer Skills Fundamentals II	6	8
	Communication and Academic Literacy Skills II	6	12
CORE COMPONENT Subjects / Units / Modules /Courses	Calculus and Analytic Geometry	6	12
	Introduction to Linear Algebra	6	12
	Introduction to Biometry	6	12
	Ordinary Differential Equations	6	12
	Computational Mathematics	6	12
	Mathematical Statistics	6	12
	Field Practical Training I	7	12
	Complex Variables with Applications to Bio-systems	7	12
	Scientific Writing and Presentation Skills	7	12
	Probability Models	7	12
	Mathematical Methods	7	12
	Introduction to Real Analysis	7	12
	Fundamentals of Scientific Computing	7	12
	Introduction to Biomathematics	7	12
	Field Practical Training II	8	12
	Research Essay I	7	12
	Mathematical Entrepreneurship and Innovation	8	12
	Research Essay II	8	12

	Generalized Linear Models	8	12
ELECTIVE COMPONENT Subjects / Units / Modules /Courses	**Set I** – Choose 3 from this set: **subset 1**: choose one from this subset Mathematical Population Dynamics Mathematical Epidemiology **Subset 2**: choose one from this subset Optimization and Control Theory Operations Research **Subset 3**: choose one from this subset Ecological Modelling Environmental Modelling Mathematical Physiology	7 8 8	12 12 12
	Set II: Choose 10 from this set: **Subset 1:** Choose 2 from this subset Introduction to Animal Science Range Ecology Principles of Crop Production Introduction to Crop Pests **Subset 2**: Choose 2 from this subset Animal Health Range Plant Eco-physiology Introduction to Soil Science Forest and Range Entomology **Subset 3**: Choose 2 from this subset Conservation Ecology Crop Physiology Principles of Crop Protection Population and Community Ecology **Subset 4**: Choose 1 from this subset Wildlife Ecology and Management Animal Diseases Pests of Field Crops Evolutionary Biology Introduction to Ecology and Conservation Plant and Animal Diversity **Subset 5**: Choose 2 from this subset Range Analysis Community Forestry	6 6 6 6 7	24 24 24 12 24

	Environmental Management Agricultural and Food Policy Agricultural Finance Landscape Ecology Restoration Ecology Land Drainage **Subset 6**: Choose 1 from this subset Poultry Production Vegetable Production Diseases of Field Crops Diseases of Horticultural Crops Policies in Wildlife Management Co-Management of Natural Resources	7	12
	Set III: Choose 1 from this set Data Mining Programming in R Artificial Intelligence Linear Programming Control Theory Machine Learning Deep Learning	8	12
			520

Rules of combinations, Credit distribution (where applicable):

Rules of Combination

This qualification has 520 credits with fundamental courses constituting 136 credits, while core and electives constitute 228 and 156 credits (13 courses), respectively.

Type	**Fundamental**	**Core**	**Elective**	**Total**
Credit value	**136**	**228**	**156**	**520**

The Credit distribution by levels

Level	**Total**
5	96
6	196
7	156
8	72
Total	**520**

The credit distribution meets the minimum requirement with 96 credits at level 5 and 228 credits above level 7 and above.

MODERATION ARRANGEMENTS

ASSESSMENT ARRANGEMENTS

Formative assessment

Formative assessment or continuous assessment contribution towards the award of credits should be based on course outcomes.

The contribution of continuous (formative) assessment to the final grade is 50%.

Summative assessment

Candidates may undergo written final examination for each course. The final examination will constitute the other 50% of the overall course grade.

Research Project: Projects will be assessed based on literature review, research aptitude, written reports and oral presentation by supervisors and independent assessors using standard evaluation form or report. The Faculty or Departmental Project Coordinator or delegated authority shall moderate learners' project for fairness of evaluation, research aptitude, report writing and presentation skills using quality assured rubrics.

MODERATION ARRANGEMENTS

The purpose of moderation is to ensure that assessment and marking across all courses is fair, valid and reliable. It also ensures that assessment tool is aligned to the stated learning outcomes, that it is set at an appropriate level of study and, that the process of marking is consistent.

Internal Moderation

Moderation for all continuous assessment tools like tests and final examinations shall be carried out by internal moderators who are qualified and experienced academic staff in the university who have been trained as assessors and moderators.

External Moderation (Verification)

The ETP will appoint appropriate qualified experts from accredited ETPs for external moderation purposes. External moderation shall be conducted on final year qualification modules. The purpose of external moderation is to monitor the standards of assessment, assessors' decisions, credibility of assessment methods and question papers, check the internal moderation processes and provide advice through the feedback reports. The feedback reports from internal moderators, question papers, marking keys and scripts will be shared with the external moderator. Sampling will be undertaken to determine the quantity of assessments to be moderated.

RECOGNITION OF PRIOR LEARNING (if applicable)

There shall be provision for award of the qualification through Recognition of Prior Learning (RPL) in accordance with institutional Policies in line with the National RPL Policy.

PROGRESSION PATHWAYS (LEARNING AND EMPLOYMENT)

- **Learning Progression Pathways**

Horizontal Articulation: (qualifications to which this qualification are equivalent to:)

i. BSc in Biometry
ii. BSc in Biodiversity
iii. BA or BSc in Statistics
iv. BSc in Pure and/or Applied Mathematics

Holders of this qualification can progress as follows:

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

i. BSc in Biomathematics (Honors),
ii. Post-Graduate Certificate in Mathematics
iii. Post-Graduate Diploma in Biomathematics
iv. MSc in Biomathematics
v. MSc in Biometry
vi. MSc in Biodiversity

- **Employment Pathways**

BSc in Biomathematics graduates can be employed as:

i. Data analysts
ii. Lecturers
iii. Teachers
iv. Researchers
v. Consultants
vi. Entrepreneurs and innovators

QUALIFICATION AWARD AND CERTIFICATION

Award
For a student to be awarded a Bachelor of Science in Biomathematics qualification, the student shall attain a **minimum accumulated of 520 credits** and attainment of all exit outcomes.

Certification
A graduate who meets the minimum credit value and has attained all exit outcomes will be awarded a **Bachelor of Science in Biomathematics**.

REGIONAL AND INTERNATIONAL COMPARABILITY

Summary:

This qualification was compared with similar or equivalent qualifications from various institutions. Their qualifications have been registered according to their respective frameworks.

Information gathered shows that there is no university locally which offers an undergraduate qualification in Biomathematics. Regionally, University of Stellenbosch, South Africa offers an undergraduate qualification in Biomathematics. At International level, there is a good number of universities offering undergraduate qualifications in Biomathematics or Mathematical Biology.

Similarities:
This qualification has many common courses/modules in basic mathematics: Calculus and Analytic Geometry, Differential Equations, Computational Mathematics, Linear Algebra, Real Analysis, Mathematical Statistics and Probability.

Differences:
This qualification focuses on applications of Mathematics to Natural, Mathematical and Life Sciences and Agriculture and Nature Conservation fields. Specific areas of applications include: Population and Community Ecology, Conservation Ecology, Plant and Animal Diversity, Evolutionary Biology; Agricultural Sciences: Animal and Crop Sciences; Natural Resources: Range Sciences and Wildlife Management.

Most of the universities benchmarked with concentrated on applications of Mathematics to Biomedical Sciences, Biological Sciences, Biophysical Sciences as well as Neurosciences and Engineering.

The credit value of this qualification structurally varies from institution to institution.

REVIEW PERIOD

This qualification shall be reviewed after five (5) years.