SECTION A:	***QUALIFICATION DETAILS***																	
QUALIFICATION DEVELOPER (S)	Botswana International University of Science and Technology																	
TITLE	Bachelor of Science Honours in Mathematical Sciences														***NCQF LEVEL***		*8*	
FIELD	Natural, Mathematical and Life Sciences			***SUB-FIELD***		Mathematical Sciences									***CREDIT VALUE***		120	
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 of the Qualification

Botswana Vision 2036 recognises education and skills development as the foundation for human resource development. The development of human capital specialised in Mathematical Sciences is essential in achieving the Vision 2036 pillars mainly Pillar 1 (Sustainable Economic Development) and Pillar 2 (Human and Social Development). The two pillars emphasise transformation of Botswana's economy to a knowledge-based economy and producing a globally competitive human resource as a key strategy to drive economic growth and diversification. Mathematical scientists and related professionals and Researchers are some of the national priority occupations as outlined in the Human Resource Development Council (HRDC) report on the areas of Research, Innovation, Science and Technology (HRDC Report 2016). The qualification of

Bachelor of Science Honours in Mathematical Sciences is thus in line with this mandate in contribution to the realisation of Vision 2036's National Development Plan 11 (NDP 11).

Stakeholders from various specialised sectors in Botswana have been consulted and remained actively engaged in the design of this qualification. The invaluable input from the industry stakeholders also helped the qualification developers to have an insight on the current and future needs in the areas where graduates of this qualification are required.

Purpose of the Qualification

This qualification is designed to train learners at Bachelor of Science Honours level in Mathematical Sciences and thus creating a foundation to their entry into related professions as mathematical modellers (in health, ecology, industry etc.), educators, data analysts, among others.

The specific purpose of this qualification is to:

- equip graduates with advanced understanding of the principles and concepts of Mathematical Sciences and its Applications.
- produce graduates who have competencies, knowledge and transferable mathematical skills that will enable them to:
  - (i) solve real-world problems in the community,
  - (ii) carry out decision-making analysis in the community, and other sectors,
  - (iii) conceptualise, design, and implement research to contribute to the existing body of knowledge in Mathematical Sciences.
  - (iv) demonstrate intellectual independence, analytic rigour, and understand and evaluate new knowledge and ideas in the Mathematical Sciences and other closely linked areas.

ENTRY REQUIREMENTS (including access and inclusion)

Entry into this qualification is through any one of the following requirements:

- The minimum admission requirement is a bachelor's degree (NCQF level 7) in the same or a cognate field of study.
- Admission may also be possible following a Post-Graduate Diploma or a Post-Graduate Certificate or relevant industry experience through Recognition of Prior Learning (RPL) and Credit Accumulation and Transfer (CAT) policies for access.

SECTION B	***QUALIFICATION SPECIFICATION***
GRADUATE PROFILE (LEARNING OUTCOMES)	***ASSESSMENT CRITERIA***
1. Utilise highly specialised knowledge from mathematical theories, principles and concepts to solve theoretical and practical problems.	1.1 Apply core concepts and principles of mathematical reasoning to solve theoretical mathematical problems. 1.2 Determine the limitations of proof techniques used in various mathematical problems. 1.3 Apply mathematical concepts and principles in solving practical problems. 1.4 Conduct supervised research in one of the areas of mathematical sciences.
2. Demonstrate the ability to gather, evaluate and manage information in order to produce a scientific document and communicate clearly and effectively to an audience	2.1 Design and apply appropriate procedures for generating mathematical science information with due concern for bias and for any ethical or safety considerations. 2.2 Examine mathematical information obtained from various resources such as books, journals, internet and other electronic resources to conduct scientific research. 2.3 Critically analyse mathematical information from a variety of sources, which may be contradictory or divergent to distinguish facts from hypotheses. 2.4 Apply appropriate mathematical techniques such as graphical, computational and deductive reasoning to analyse mathematical information.

	2.5 Provide scientific evidence from such analysis with valid arguments and qualitatively assess the validity of arguments presented. 2.6 Demonstrate a system of knowledge in mathematical analysis to produce scientific document. 2.7 Produce oral presentations that communicate Mathematical/Scientific information for the intended audience.
3. Demonstrate key scientific reasoning skills to cross examine logical flow of arguments.	3.1 Demonstrate logical thinking and identify naive and flawed mathematical reasoning. 3.2 Demonstrate the ability to judge when appropriate mathematical principles have been used, or a problem has been adequately solved.
4. Develop advanced mathematical approaches to solve real world problems.	4.1 Formulate, analyse and solve both concrete and abstract problems. 4.2 Apply advanced mathematical theories, concepts and principles to solve practical and/or theoretical problems. 4.3 Generate innovative solutions to specific problems.
5. Carry out research and explain the results to relevant audiences.	5.1 Formulate a research problem. 5.2 Assemble a theoretical base appropriate to the topic involving a critical analysis of the literature and proper use of citation within arguments. 5.3 Select appropriate research methods and associated research design. 5.4 Apply analytical, critical and creative thinking skills to solve problems. 5.5 Draw appropriate inferences and conclusions. 5.6 Produce a substantial report giving an honest account of research undertaken. 5.7 Present the results of the research work in a conference setting.

6. Work effectively with others as a member of a team, group, organisation and community in scientific projects or investigations.	6.1 Provide evidence of working effectively as a member of a team or group in scientific projects or investigations with significant contribution. 6.2 Outline the key capability to initiate, organise and manage group works. 6.3 Communicate effectively the outcomes of scientific group work to the relevant audience.

SECTION C	***QUALIFICATION STRUCTURE***				
COMPONENT	***TITLE***	***Credits Per Relevant NCQF Level***			***Total (Per** Subject/ Course/ Module/ Units)*
		Level [6]	***Level [7]***	***Level [8]***	
FUNDAMENTAL COMPONENT *Subjects/ Courses/ Modules/Units*					
CORE COMPONENT *Subjects/Courses/ Modules/Units*	**Core Component Total Credit Hours**				**72**
	Measure and Integration Theory			12	12
	General Topology			12	12
	Module Theory			12	12
	Honours Project in Mathematics			36	36
ELECTIVE/ OPTIONAL COMPONENT *Subjects/Courses/ Modules/Units*	**Electives Modules: Choose four Modules (48 credits) from the following list.**				***48***
	Fundamental Concepts of Geometry			12	12
	Mathematical Biology I			12	12
	Axiomatic Set Theory			12	12

	Selected Topics in Algebra			12	12
	Applied Algebraic Topology			12	12
	Selected Topics in Analysis			12	12
	Numerical Analysis II			12	12
	Mathematical Biology II			12	12
	Mathematical Biology III			12	12
	Optimal Control			12	12
	Stochastic Differential Equations			12	12
	Dynamical Systems			12	12
	Advanced Mathematical Analysis			12	12
	Methods of Complex Analysis			12	12
	Financial Mathematics			12	12
	Advanced Optimization and Applications			12	12
	Advanced Probability			12	12

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SUMMARY OF CREDIT DISTRIBUTION FOR EACH COMPONENT PER NCQF LEVEL
TOTAL CREDITS PER NCQF LEVEL

NCQF Level	*Credit Value*
8	120
TOTAL CREDITS	***120***

Rules of Combination:

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

- This qualification will have 120 credits. The credit combination for the qualification is from 72 core components and 48 elective components.
- For Elective Components, choose at least four modules (48 credits) from the list of elective modules.

ASSESSMENT ARRANGEMENTS

ASSESSMENT: All assessments, formative and summative, leading to the award of credits in this qualification shall be based on module learning outcomes, and the qualification exit-level outcomes.

- **Formative Assessment** - A formative assessment aligned to the module learning outcomes and exit-level outcomes will be administered continuously throughout the learning period in each module. The recommended weights of the formative assessment should be at least 50% and should not exceed 60% of the final marks for that module.
- **Summative Assessment** - Learners shall undergo a summative assessment which may include a written examination at the end of learning period in each module. The recommended weights of the summative assessment will vary from 50% to 40% of the final marks for that module. All summative practical assessments must, as far as possible, be conducted in real-work settings.

MODERATION ARRANGEMENTS

MODERATION: Pre-assessment moderation will be carried out before administering assessments that contribute towards the award of credits in this qualification and post-assessment moderation will be carried out after the assessment tasks have been marked.

- **Internal Moderation** - Assessment instruments shall be subjected to internal moderation by BQA registered and accredited Assessors and Moderators before administering to ensure fairness, validity, reliability and consistency of assessments.
- **External Moderation** - Exit level assessment instruments shall be moderated by an External Moderator to ensure fairness, validity, reliability and consistency of assessments. Qualified external moderators shall be appointed from an accredited Education Training Provider (ETP).

RECOGNITION OF PRIOR LEARNING

- Recognition of Prior Learning (RPL) will be considered in the award of the qualification in accordance with applicable RPL policy of the ETP which are aligned to BQA/National policies on the same.
- Credit transfer will be awarded in accordance with applicable ETP CAT policies and guidelines which are aligned to BQA/National policies on the same.

CREDIT ACCUMULATION AND TRANSFER

Recognition of Prior Learning (RPL) will be considered in the award of the qualification in accordance with applicable RPL policy of the ETP which are aligned to BQA/National policies on the same.

Credit transfer will be awarded in accordance with applicable ETP CAT policies and guidelines which are aligned to BQA/National policies on the same.

PROGRESSION PATHWAYS (LEARNING AND EMPLOYMENT)

LEARNING PATHWAYS

This qualification is intended to provide learners with both horizontal and vertical articulation pathways, nationally, regionally and internationally:

Horizontal Articulation

The qualification articulates horizontally with various local, regional and international Bachelor of Science Honours Degrees and Postgraduate Diplomas in related areas. Qualifications of similar level at NCQF Level 8 include:

- Bachelor of Science Honours in Statistics,
- Bachelor of Science Honours in Actuarial Science,
- Bachelor of Science Honours in Financial Mathematics,
- Bachelor of Science Honours in Financial Engineering,
- Bachelor of Science Honours in Industrial Mathematics

Vertical Articulation

The qualification provides vertical articulation to higher level qualifications at NCQF level 9. The graduate of this qualification can thus progress to enrol to NCQF Level 9 such as:

- Master of Science in Financial Mathematics,
- Master of Science in Actuarial Sciences,
- Master of Science in Statistics,
- Master of Science in Quantitative Finance,
- Master of Science in Applied Mathematics,
- Master of Science Mathematics.0

EMPLOYMENT PATHWAYS

Mathematical Sciences graduates apply their problem-solving skills to a wide variety of fields and upon successful completion of the degree, graduates qualify to work in the following sectors:

- Data analyst in any field including climate change, public health, agriculture and natural resources in government and private institutions,
- Research scientist in academic and research institutions,
- Teachers/Teaching Assistant in public and private institutions,
- Researchers in public and private institutions,
- Consultant in educational institutions and industries,
- Information technology and computing (coding, cryptography),
- Other government agencies where judicious planning of resources and implementation of policies are required.

QUALIFICATION AWARD AND CERTIFICATION

Minimum standards of achievement for the award of the qualification

Candidate(s) will be awarded the degree of Bachelor of Science Honours in Mathematical Sciences after attaining the stipulated minimum credits of 120; inclusive of 72 credits from core modules and 48 credits from elective modules as specified in the rules of combination and credit distribution.

Certification

Candidates meeting prescribed requirements will be awarded the qualification in accordance with standards prescribed for the award of the qualification and applicable policies. A certificate of the award of the degree of Bachelor of Science Honours in Mathematical Sciences will be given upon successful completion of the qualification. 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

The South Africa Qualification Authority (SAQA) Bachelor of Science Honours qualification is at Level 8 and takes one year to complete. The entry requirement is a BSc Level 7. It is worth of 135 credits. There are

specializations in Mathematics, Applied Mathematics, Actuarial and Financial Mathematics. The modes of assessment include Portfolios, Simulations, Written Examinations and Oral Examinations.

The Bachelor of Science Honours qualification owned by the Australian National University is a one-year qualification worth at least 48 units with at least 24 units of course work and 24 units of a project. Topics include a Project, Computational Mathematics, Algebraic Topology, Partial Differential Equations and a special topic in mathematics. The assessment consists of assignments, workshops, presentations, mid semester exams and final exams. The entry requirement is a BSc degree in the Mathematical Sciences. The exit learning outcomes fairly compare to the Exit Learning Outcomes (ELO's) of the proposed Bachelor of Science Honours in Mathematical Sciences.

Both programmes compare very well to the proposed Bachelor of Science Honours qualification in Mathematical Sciences in terms of duration, learning outcomes, topics covered, research component, number of credits or units and assessment methods.

REVIEW PERIOD

The qualification will be reviewed after 5 years.

Provider: Botswana International University of Science and Technology	**Faculty/Department:** Department of Mathematics and Statistical Sciences
Title of Proposed Qualification:	Bachelor of Science Honours in Mathematical Sciences

Comparability Matrix of Qualifications	**Subfield:** Mathematical Sciences
Introductory Statement	
Benchmarking has been done against a sample of similar types and levels qualifications and/or programmes offered within the region and beyond to appreciate international trends and practices in relation to exit level descriptors and scope of content covered and ascertain regional and international comparability and articulation of the proposed qualification. The outcomes of this process are highlighted below.	

Name of University (and Country)	**Title of Qualification, NQF Level & Credit Value**	**Main Exit Outcome(s)**	**Domains/Modules/ Courses/Subjects covered (Fundamental, core & electives)**	**Assessment strategies and Weightings**	**Qualification rules and minimum Standards for the award of the qualification**	**Education and Employment Pathways**
University of Pretoria, South Africa	BSc (Honours), Mathematical Sciences, Level 8, Credits 135.	On completion, the students will be able to: 1) conceptualise, evaluate and understand theory and models in the	The Honours qualification includes the following core and elective courses: **Core Courses:** • Project: 30 credits,	Integrated assessment: Portfolios, Simulations, Written examinations, Oral examinations	A minimum of: 135 credits inclusive of 105 core credits 30 elective credits.	Education Pathway: MSc in Mathematical Sciences. Employment Pathway: Not indicated.

		mathematical sciences at an Honours level. 2) identify, access, formulate and solve problems stemming from mathematical situations in society, by being able to meaningfully observe and identify such situations, to convert these observations into mathematical language and to reach logical conclusions on an Honours level. 3) identify and solve problems of mathematical nature in science and in real-	• Functional Analysis, • Axiomatic Set Theory, • Topology, • Algebra, • Measure Theory and Probability, • Partial Differential Equations, **Elective Courses** • Numerical Analysis, • Mathematical Optimization, • Stochastic Calculus, • Mathematical methods and models, • Continuum Mechanics.			

		life situations through critical and creative thinking; 4) work effectively with others as a member of a team, group, organisation, community through joint projects and discussion; 5) organise and manage himself and his activities responsibly and effectively; 6) collect, analyse, organise and interpret				

		empirical information scientifically; 7) communicate effectively through visual, mathematical and language skills; 8) use science and technology effectively and critically in such a way that people's health and the environment is preserved and improved; 9) demonstrate and understand the multidisciplinary nature of mathematical science, thereby also				

		recognising that problem-solving contexts do not exist in isolation				
Cardiff University Wales, United Kingdom.	MMath , Credits 480, Level:Not specified. The Mmath is 4-year qualifiaction after completing A-level.	On completion, the students will be able to: 1) demonstrate a good understanding of knowledge in the main areas of mathematics, 2) critically analyse the diversity of abstract mathematical concepts using logical argument and deductive reasoning.	The Honours qualification includes the following core and elective courses: **Core** Elementary Differential, Equations, Computing for Mathematics, Geometry, Foundations of Mathematics I, Foundations of Mathematics II, Linear Algebra I, Introduction to Probability Theory, Calculus of Several Variables,	Coursework, Written examinations, Practical Examinations. Project report. Project presentation, Group work and presentation	At least 480 credits, including 210 core credits and at least 270 optional credits.	Education Pathway: MSc in Mathematical Sciences. Employment Pathway: data science, operational research, internet technology, medicine, banking, logistics, risk management, and marketing.

		3) apply mathematical theories in problem-solving.	Complex Analysis, Series and Transforms, Real Analysis, Linear Algebra II, Vector Calculus, MMath Project **Optional** Introduction to Number Theory I, Algebra I: Groups Vibrations and Waves, Modelling with Differential Equations, Foundations of Probability and Statistics, Operational Research, Numerical Analysis, Finance II: Investment Management, Problem Solving,			

			Introduction to Functional and Fourier Analysis, Coding Theory, Algebraic Topology, Introduction to Number Theory, Ordinary Differential Equations, Algebra II: Rings, Algebra III: Fields, Partial Differential Equations, Measure Theory, Methods of Applied Mathematics, Fluid Dynamics, Finite Elasticity, Regression Analysis, and Experimental,			

			Stochastic Processes for Finance and Insurance, Algorithms and Heuristics, Optimization, Game Theory, Algorithms and Heuristics, Theoretical Fluid Dynamics, Combinatorial and Analytic Number Theory, Mathematical Foundations of Quantum Physics, Advanced Topics in Analysis: Sobolev Spaces and Viscosity Solutions,			

			Quantum Information Theory , Mathematical Biology, Statistics of Big Data, Stochastic Search and Optimisation, Reading Module.			
Australian National University.	BSC Honours in Mathematical Sciences, Level 8, Units 48. Note that 48 units correspond to 120 credits in the Botswana National Credit and Qualifications framework	On completion, the students will be able to: 1)Explain the fundamental concepts of a chosen research topic and its role in modern mathematics and applied contexts. 2) Systematically identify relevant theory and concepts, relate these to appropriate methodologies and evidence, and draw	The Honours qualification includes the following courses: • Computational Mathematics, • Partial Differential Equations, • Algebraic Topology, • Special Topics in Mathematics.	Assignments, Workshops, Presentations, Mid semester, exams Final exams	A minimum of 48 units 24 units coming from the research project.	Education Pathway: MSc in Mathematical Sciences. Employment Pathway: Not indicated

		appropriate conclusions. 3) Demonstrate capacity for mathematical reasoning through analysing, proving and explaining concepts from the chosen research area. 4) Engage in systematic discovery and critical review of appropriate and relevant information sources. 5) Communicate research concepts and contexts clearly and effectively both in writing and orally.				

Summary of Similarities and Differences Observed

The South Africa Qualification Authority (SAQA) Bachelor of Science Honours qualification is at Level 8 and takes one year to complete. The entry requirement is a BSc Level 7. It is worth of 135 credits. There are specializations in Mathematics, Applied Mathematics, Actuarial and Financial Mathematics. The modes of assessment include Portfolios, Simulations, Written Examinations and Oral Examinations.

The Bachelor of Science Honours qualification in Mathematical Sciences at Cardiff University (Wales, United Kingdom) is a four-year qualification based on the Framework for Higher Education Qualifications of Degree-Awarding Bodies in England, Wales, and Northern Ireland (FHEQ) and is at Level 6 (Foundation degrees). It is accredited by the Institute of mathematics and its Applications (IMA). The entry requirement is an A-level Mathematics. The minimum credits to be awarded a degree is 480 with a core Bachelor of Science Honours project worth 40 credits. Other courses are optional depending on the specialization. For the assessment, the examination carries 100% of marks in most modules.

The Bachelor of Science Honours qualification owned by the Australian National University is a one-year qualification worth at least 48 units with at least 24 units of course work and 24 units of a project. Topics include a Project, Computational Mathematics, Algebraic Topology, Partial Differential Equations and a special topic in mathematics. The assessment consists of assignments, workshops, presentations, mid semester exams and final exams. The entry requirement is a BSc degree in the Mathematical Sciences. The exit learning outcomes fairly compare to the Exit Learning Outcomes (ELO's) of the proposed Bachelor of Science Honours in Mathematical Sciences.

Comparability and articulation of the proposed qualification with the ones examined
All the three programmes compare very well to the proposed Bachelor of Science Honours qualification in Mathematical Sciences in terms of duration, learning outcomes, topics covered, research component, number of credits or units and assessment methods.