BQA NCQF QUALIFICATION TEMPLATE

SECTION A:	QUALIFICATION DETAILS
QUALIFICATION DEVELOPER (S)	Botswana International University of Science and Technology

TITLE	Master of Engineering in Biomedical Engineering	NCQF LEVEL	9
STRANDS (where applicable)	1. 2. N/A 3. 4.		
FIELD	Manufacturing, Engineering and Technology	SUB-FIELD	Engineering and Engineering Trades
CREDIT VALUE	270		

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:

The Global Innovation Index Report titled “Creating Healthy Lives- The Future of Medical Innovation” describes today's innovation in health as more than just developing new medicine but also engaging in research and development of equipment capable of assisting in the diagnosis of diseases and devices for health monitoring and treatment. In the Sub-Saharan Africa region Botswana is nowhere near the top contenders; South Africa, Kenya, and Mauritius in innovation economies. Vision 2036

advocates for Batswana to attain the necessary skills and competencies that will drive innovative solutions to leading challenges in various local sectors including the healthcare.

Currently there is no local institution of higher learning that offers postgraduate degree qualification in Biomedical engineering. Prior to 1999, most Biomedical engineering Technicians were employed with Diploma qualifications mostly in electronics and electrical engineering obtained from local vocational training institutions and the then Faculty of Engineering and Technology (FET) in Gaborone. To work as a medical equipment maintenance Technician, the employer would organize in-service training by paying the suppliers to provide such service or pay for maintenance contract with the Supplier. It wasn't until the 2000s that the government offered sponsorship opportunities for Batswana to study for Biomedical engineering degree qualification abroad. By doing so, the diploma holders were given the opportunity to further their studies in South African Technical Institutions for a BTech qualification, not necessarily in Biomedical Engineering but Electronics Engineering. The establishment of the first ever government-owned medical school, the Sir Ketumile Masire Teaching Hospital, has already created opportunities for Industrial training in Biomedical engineering.

Development of the human capital is essential in achieving the VISION 2036 pillars mainly Pillar1: Sustainable Economic Development and Pillar 2: Human and Social Development. These two pillars emphasize transformation of Botswana economy to a knowledge-based economy producing a globally competitive human resource. They represent key strategies for driving economic growth and diversification. This qualification, MEng in Biomedical Engineering contributes towards Vision 2036's realization by equipping prospective graduates with the necessary skills and competencies necessary to grow the medical devices innovation and diagnostic technologies in Botswana.

One of the key factors in advancing a knowledge-based economy is the growth of the innovative industry, achieved through providing quality postgraduate research studies locally, where trainees innovate solutions through groundbreaking research that addresses the leading medical and engineering problems in Botswana. Currently, leading suppliers of advanced medical devices are foreign companies who control the market value, knowledge, and training, putting developing nations at a disadvantage. As much as medical devices are designed to cater to global needs, developing nations such as Botswana are still on the disadvantaged side in terms of access to some of the advanced healthcare technology due to the nature of their small economies. Botswana is heavily reliant on South Africa's healthcare technology at a devastating cost.

The structured Master of Engineering in Biomedical Engineering qualification is aimed at developing specialist researchers, with particular ability to develop new or improve existing technology at the

forefront of clinical and industrial aspects of biomedical engineering. They will be able to develop novel, complex biomedical engineering systems by integrating the medical and the engineering domains. The graduates will be able to apply these systems to human patients, addressing healthcare needs of Botswana and of global communities.

The programme prepares the candidate for research, academic or consulting careers in both hospitals and private industry. It requires a candidate to undertake independent research, with minimal supervision, at the most advanced academic levels culminating in the submission, assessment and acceptance of a written thesis, as well as two research papers suitable for submission to peer-reviewed journals. The defining characteristic of this qualification is that the candidate is required to demonstrate advanced knowledge of the fundamental theoretical subjects and apply them to leading biomedical engineering research gaps.

PURPOSE: (itemise exit level outcomes)

The purpose of the Master of Engineering in Biomedical engineering qualification is to equip graduates with advanced knowledge, skills and competence enabling them to:

- Apply biomedical engineering specialized expertise in areas such as medical instrumentation, biomaterials, biomechanics, medical imaging and tissue engineering to identify, screen and validate unmet clinical needs.
- Design, develop and implement innovative and value-based biomedical devices and therapeutics technologies within the bounds of the needs of patients and healthcare givers, medical device regulations and ethical standards of biomedical engineering practice.
- Lead and collaborate effectively in both engineering and medical environments by translating clinical needs into engineering solutions and vice versa.
- Contribute to cutting-edge research in areas, while pursuing further academic studies or in research and development professions and communicate research findings and technical concepts, effectively through scholarly articles and presentations.
- Recognize the need for and ability to advance biomedical engineering careers in roles including leadership, research and development, entrepreneurship, and higher levels of responsibility in professional regulatory bodies.

MINIMUM ENTRY REQUIREMENTS (including access and inclusion)
Entry into this qualification is through the following requirements: • NCQF level 8 Bachelor of engineering degree qualification in Biomedical engineering or its equivalent • Credit Accumulation and Transfer (CAT) or Recognition of Prior Learning (RPL) can be considered through applicable policy.

SECTION B	*QUALIFICATION SPECIFICATION*
GRADUATE PROFILE (LEARNING OUTCOMES)	**ASSESSMENT CRITERIA**
1. Solve leading research gaps in biomedical engineering by comprehensively understanding and contextualizing issues and ideas.	• Critically evaluate proposed research methodologies for rigor and robustness. • Assess the reliability and validity of results generated by the proposed research approach. • Analyze the relevance and impact of the research in addressing significant gaps within the biomedical engineering field.
2. Develop innovative solutions to unmet challenges in biomedical engineering and related fields.	• Identify and analyze user needs to guide the development of biomedical engineering solutions. • Generate and iterate on design concepts through prototyping to address identified user needs.

	• Evaluate the performance and feasibility of the developed biomedical devices and systems in meeting the intended objectives.
3. Conduct independent research in biomedical engineering to contribute to professional practice.	• Formulate clear and actionable research questions addressing specific biomedical engineering gaps. • Design and execute experiments, employing appropriate modern engineering and computational tools. • Analyze data critically and draw conclusions that contribute to advancing professional practice in biomedical engineering.
4. Function effectively as integral members of multidisciplinary teams.	• Demonstrate leadership and collaborative skills in multidisciplinary projects. • Apply conflict resolution and team-building strategies to enhance team cohesion and productivity. • Contribute unique expertise while leveraging the diverse skills of team members to achieve shared objectives.
5. Adhere to ethical principles and professional engineering standards and practices.	• Apply ethical reasoning and professional engineering standards to decision-making processes. • Ensure compliance with relevant regulatory frameworks and intellectual property laws in engineering projects. • Evaluate biomedical engineering technologies' societal impacts and patient

	safety considerations, implementing strategies to mitigate negative outcomes.
6. Recognize the necessity for independent and lifelong learning.	• Develop personal strategies for staying informed of emerging technologies and practices in biomedical engineering. • Engage in professional development opportunities, including workshops, seminars, and conferences. • Apply new knowledge and skills to ongoing professional practice, demonstrating adaptability and growth.

SECTION C	***QUALIFICATION STRUCTURE***				
COMPONENT	***TITLE***	***Credits Per Relevant NCQF Level***			***Total Credits***
		Level [ ]	***Level [ ]***	***Level [ ]***	
FUNDAMENTAL COMPONENT *Subjects/ Courses/ Modules/Units*					
CORE COMPONENT *Subjects/Courses/ Modules/Units*	Applied Mathematics for Engineers			*12*	
	Statistical Methods			*12*	
	Advanced Material Science			*12*	
	Biomedical Engineering			*12*	
	Research Methodology			*12*	
	Professional communication skills			*12*	
	Graph Theory and Optimization Techniques			*12*	
	Modelling of Biological Tissues			*12*	

	Biomedical Engineering Masters Research Proposal			*12*	
	Biomedical Engineering Masters Research Thesis			*90*	
STRANDS/ SPECIALIZATION	*Subjects/ Courses/ Modules/Units*	***Credits Per Relevant NCQF Level***			***Total Credits***
		Level [ ]	***Level [ ]***	***Level [ ]***	
1.					
2.					
Electives	Biomedical Optics and Imaging			*12*	
	Artificial Intelligence			*12*	
	Advanced Digital System Design			*12*	

	Advanced Fluid Mechanics			*12*	
	Advanced Biomaterials and Tissue Engineering			*12*	
	Advanced Bioinstrumentation			*12*	
	Magnetic Resonance Imaging			*12*	
	Advanced Biomedical Transport and Rate Process			*12*	
	Musculoskeletal Biomechanics			*12*	
	Biosensors and Diagnostics			*12*	
	Rehabilitation Engineering			*12*	
	Bioinformatics			*12*	
	Computational Modeling of Physiological Systems			*12*	
	Othopedic and Prosthetic Engineering			*12*	
	Ultrasound Technology and Applications			*12*	
	Advanced Musculoskeletal biomechanics			*12*	
	Medical Imaging			*12*	

	Microscopy and Optics			*12*	
	Total Credits			*270*	

SUMMARY OF CREDIT DISTRIBUTION FOR EACH COMPONENT PER NCQF LEVEL	
TOTAL CREDITS PER NCQF LEVEL	
NCQF Level	*Credit Value*
9	*270*
TOTAL CREDITS	*270*
Rules of Combination: ***(Please Indicate combinations for the different constituent components of the qualification)***	
To graduate with a Master of Engineering degree in Biomedical Engineering, a learner is required to complete two years of studies and successfully accumulate a minimum of 270 Credits according to the following combination: Core Modules = 198 Credits Electives = 72 credits	

ASSESSMENT ARRANGEMENTS

1. **Formative Assessment:**

   Weighting: 40%

2. Summative Assessment:

   Weighting: 60%

MODERATION ARRANGEMENTS

This qualification is moderated as follows:

Internal Moderation - Assessment instruments shall be subjected to both internal and external moderation by BQA registered and accredited Assessors and Moderators or equivalent authority.

RECOGNITION OF PRIOR LEARNING

Recognition of Prior Learning (RPL) will be considered for the award of this qualification by the university's applicable policies. RPL acknowledges the value of learning acquired from previous formal, non-formal, and informal experiences, offering a pathway to gain academic credits towards the qualification. Further details on the RPL process, including application and assessment, are available through the university's RPL policy documentation.

CREDIT ACCUMULATION AND TRANSFER

Credit Accumulation and Transfer (CAT) and Recognition of Prior Learning (RPL) will be considered for award of Qualification.

PROGRESSION PATHWAYS (LEARNING AND EMPLOYMENT)

Learning Pathway: Those who have achieved the qualification can progress as mentioned below:

Vertical

Completion of a Master of Engineering in Biomedical Engineering meets the requirement for admission to a

- PhD in Biomedical Engineering
- PhD in Medical Instrumentation

- PhD in Electronics
- PhD in Materials Engineering
- PhD in Control and Instrumentation
- PhD in Mechatronics and Design

Horizontal:

A Master of engineering in Biomedical Engineering candidate could continue to pursue a master's degree program in any other university in the Biomedical Engineering specialized disciplines such as

- MEng in Electronics Engineering
- MEng in Materials Engineering
- MEng in Clinical Engineering
- MEng in Medical Instrumentation Engineering
- MEng Control and Instrumentation
- MEng in Mechatronics and Design

Employment Pathway:

The MEng in Biomedical Engineering graduates are suitable for a career in the following in various institutions such as, Academia, Government, Private Sectors, Professional and Standards regulatory agencies and business sector as any of the following:

- Bioinstrumentation engineers
- Academic Professionals
- Research Assistants
- Biomedical engineering Hospital Managers
- Medical Devices Sales consultants
- Medical Devices regulatory authority engineer
- Biomedical Maintenance Engineer
- Biomedical Engineering Consultant
- Clinical Engineer
- Bioimaging engineer
- Biomaterials Engineer
- Rehabilitation engineering

QUALIFICATION AWARD AND CERTIFICATION

A learner will be awarded a Master of Engineering in Biomedical Engineering degree qualification when they attain 270 credits and awarded the qualification certificate.

SUMMARY OF REGIONAL AND INTERNATIONAL COMPARABILITY

The MEng in Biomedical Engineering qualification was compared with the following three qualifications offered internationally:

MEng in Biomedical Engineering, University of South Wales, Sydney, Australia, AQF:9

MEngSc in Biomedical Engineering, Stellenbosch University, RSA NCQF Level 9

MEng. Biomedical Engineering, University of Glasgow, Scotland, SCQF level 12.

Summary of Similarities

The proposed MEng Biomedical engineering qualification compares well with the three qualifications presented above in some of key factors such as the name of the qualification, duration of study, curriculum structure/domains covered, comprising of core modules, optional/electives and research project component assessment criteria and qualification framework level. The credit system is slightly different for all qualifications. The main exit outcomes are similar as well. The proposed programme is similar to that of Stellenbosch University for the requirement of award of degree. One journal publication as first author is required. The proposed qualification has similar education and employment prospects like all the three bench marked qualifications. The proposed MEng Biomedical Engineering qualification is similar to Stellenbosch University and University of Glasgow with the same number of 60 credits towards the research project.

Both University of South Wales and Stellenbosch offer a structured Master of Engineering qualification in Biomedical Engineering, which is a qualification level 9 respective to their qualification frameworks. All three Universities offer 2 years length of study for their qualifications. All three universities have similar main exit outcomes. University of South Wales and University of Glasgow both require a written research report without publication. All three Universities have similar curriculum structure that comprises of core modules, electives/optional and a research project carrying the bulk of the credits. All three Universities have similar education and employment pathways.

REVIEW PERIOD
5 years in line with the NCQF

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For Official Use Only:

CODE (ID)			
REGISTRATION STATUS	**BQA DECISION NO.**	**REGISTRATION START DATE**	**REGISTRATION END DATE**
LAST DATE FOR ENROLMENT		**LAST DATE FOR ACHIEVEMENT**	