| ***SECTION A:*** | ***QUALIFICATION DETAILS*** | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***QUALIFICATION DEVELOPER (S)*** | **UNIVERSITY OF BOTSWANA** | | | | | | | | | | | | | | | | | |
| ***TITLE*** | Bachelor of Science in Geomatics | | | | | | | | | | | | | | ***NCQF LEVEL*** | *7* | | |
| ***FIELD*** | Manufacturing, Engineering and Technology | | ***SUB-FIELD*** | Geomatics | | | | | | | | | | | ***CREDIT VALUE*** | *527* | | |
| *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:***

In 2008, when the qualification was developed, the Government was sponsoring students to study Geomatics abroad. At the time consultations with the geomatics industry through the Ministry of Lands and Housing (Ministry Land Management, Water and Sanitation Services), indicated that there were deficiencies in the number of Geomatics Professionals in Botswana. All stakeholders supported the

development of this qualification (see Appendix – Minutes of the Stakeholder consultation meeting/Department of Civil Engineering Advisory Board).

One of key objectives of Botswana's Vision 2036 is to develop education, training, and skills development systems to embrace science, innovation, and technology. This key objective helps HRDC's inspiration to address the human resource deficit in Geomatics. In the HRDC report of 2016, Geo-informatics was categorically highlighted among the Top Occupations in the Mining, Minerals, Energy and Water Resources sector. In the same report of 2016, Surveying (Geomatics) was listed among the Top 20 Occupations in High Demand in the Creative Industries Sector. From the Forecasts for Botswana's Top Occupations in Demand (2019-2028), Surveyors (Geomatics specialists) form part of the Top National Occupations with the deficit growing from 230 in 2019 to 324 in 2028. This qualification therefore addresses the following three pillars *of Vision 2036* by supporting 'sustainable economic development, human and social development and sustainable environment', as well as two key future imperatives of 'innovation and sustainability'.

The role and contributions of Geomatics are also significant in the achievement of the following key objectives in Botswana's NDP11 (pages 108, 127, 140, 142 and 147):

- National mapping programme
- Demarcation of the international boundaries
- Densification of the national control framework
- Establishment of the Continuous Operating Reference System (CORS)
- Land information management programme
- E-Government and NSDI initiatives
- Smart cities initiative (Smart Botswana)
- Digital transformation programme
- The improvement of land administration through the LAPCAS project.

The role of Geomatics Specialists in supporting socio-economic development is also visible in meeting the following Botswana's domesticated SDG targets: ensuring ownership and control over land and other

forms of property (SDG target 1.4); integrated water resources management at all levels (SDG target 6.5); developing quality, reliable, sustainable and resilient infrastructure (SDG target 9.1); ensuring access for all to adequate, safe and affordable housing and basic services and upgrade slums (SDG target 11.1), and to increase significantly the availability of high-quality, timely and reliable geospatial data (SDG target 17.18).

The qualification will not only produce creative, competent, and motivated professional graduates for the geomatics industry but also graduates who are capable of independent, critical, and innovative thinking as well as lifelong learning. It will contribute significantly to national strategic goals by among others:

Fulfil the needs of the Botswana Geomatics industry for degree holders in Geomatics.
Contribute to National Development Plan 11 objectives with respect to the diversification of Botswana's economy.
Fulfil the Vision 2036 agenda on innovation and sustainability.
Increased diversity of Geomatics industry qualifications offered in Botswana.

PURPOSE:

The purpose of the qualification is to inform and expand knowledge, partly or mostly through research, on different technical and managerial issues of Geomatics activities in pursuit of sustainable development. Graduates of this qualification will be able to:

- Apply survey techniques to establish geodetic networks for both vertical and horizontal control.
- Apply knowledge and understanding of the principles of cadastral, topographical, deformation and as-built surveys.
- Plan, specify and give reasoned advice on engineering surveys; define and assess accuracies and tolerances; manage the engineering surveying element in large projects; and understand the principles of good engineering practice.

- Demonstrate knowledge and understanding of the principles of cartography, map design and production processes, remote sensing, and photogrammetry (both aerial and terrestrial), remote sensing techniques, scales, camera and satellite principles and different data capture methods.
- Demonstrate knowledge and understanding of the principles of geographic information science and systems. This includes industry standard GIS, data structures, types, and their applications, and of appropriate capture and output systems.
- Apply knowledge of the principles of land registration, land management, administration and legislation related to rights in real estate internationally and nationally.
- Demonstrate knowledge and understanding of the techniques for conflict avoidance, conflict management and dispute resolution procedures including for example adjudication and arbitration.

***ENTRY REQUIREMENTS (including access and inclusion)***

- Certificate IV (NCQF level 4), BGCSE equivalent
- There is provision for entry through Recognition of Prior Learning (RPL), or Credit Accumulation and Transfer (CAT).

| ***SECTION B*** | ***QUALIFICATION SPECIFICATION*** |
|---|---|
| ***GRADUATE PROFILE (LEARNING OUTCOMES)*** | ***ASSESSMENT CRITERIA*** |
| LO1. Demonstrate knowledge and understanding of survey techniques to establish geodetic networks for both vertical and horizontal control. | 1.1 Demonstrate competency in setting up surveying equipment.<br>1.2 Design and build geodetic control network for supporting survey work.<br>1.3 Carry out conventional position fixing.<br>1.4 Plan and execute relevant Global Navigation Satellite Systems (GNSS) surveys to appropriate levels of accuracy, including data processing.<br>1.5 Use standard commercial GNSS processing packages and appropriate transformation routines to transform GPS based coordinates to national datums. |
| *LO2.* Apply knowledge and understanding of the principles of cadastral, topographical, deformation and as-built surveys. | 2.1 Carry out a survey of a layout design plan.<br>2.2 Undertake topographic and as-built surveys then process survey data into map products.<br>2.3 Monitor ground movement in a subsidence area using survey instrumentation and methods.<br>2.4 Monitor the effect of ground movement on a building/structure. |
| *LO3.* Plan, and execute engineering surveys. | 3.1 Compute engineering designs e.g., Horizontal alignment calculations |

| | |
|---|---|
| | 3.2 Build 3D digital models e.g., buildings, roads, bridges, etc<br>3.3 Setting out engineering structures<br>3.4 Conduct volumetric surveys and Compute areas and volumes.<br>3.5 Provide reasoned advice on engineering surveys. |
| *LO4.* Demonstrate knowledge and understanding of the principles of cartography, map design and production processes. | 4.1 Apply principles of map projections in map design.<br>4.2 Create aesthetically pleasing maps consisting of all relevant map elements.<br>4.3 Demonstrate map reading and comprehension skills.<br>4.4 Show competency in appropriate use of cartographic software.<br>4.5 Demonstrate competency in web mapping and publishing. |
| *LO5.* Demonstrate knowledge and understanding of the principles of remote sensing and photogrammetry (both aerial and terrestrial). | 5.1 Demonstrate competency in setting up photogrammetric equipment.<br>5.2 Plan and execute provision of photo control points.<br>5.3 Demonstrate knowledge and application of digital surface modelling techniques.<br>5.4 Demonstrate competency in the use and application of different satellite imagery products.<br>5.5 Apply different digital image processing techniques to produce map products.<br>5.6 Show competency in appropriate use of photogrammetry and remote sensing software. |
| *LO6.* Demonstrate knowledge and understanding of the principles of geographic information science and systems which includes industry | 6.1 Apply principles of spatial data analysis and implement these with typical GIS algorithms using |

| | |
|---|---|
| standard Geographic Information Systems (GIS), data structures, types and their applications, and of appropriate capture and output systems. | standard functionality and/or a high-level programming language.<br>6.2 Apply query languages in relation to database management systems e.g., data modelling, data loading, data maintenance, query, translate data formats, data export.<br>6.3 Identify, assess, and source datasets appropriate to user requirements and determine their quality and fitness for purpose in the context of quantitative and qualitative measures such as: spatial resolution, accuracy/precision, temporal resolution, purpose of original capture etc.<br>6.4 Show understanding and application of international de jure and de facto industry standards and how these apply in local jurisdictions and to local customs and practices.<br>6.5 Show competency in appropriate use of GIS software. |
| *LO7.* Apply knowledge of the principles of land registration, land management, administration and legislation related to rights in real estate internationally and nationally. | 7.1 Use the principles of land information management in the design, operation, and improvement of land registration and cadastral survey systems.<br>7.2 Demonstrate how the benefits of land registration systems depend on land information management.<br>7.3 Demonstrate the benefits of cadastral systems in land management, land administration and land reform.<br>7.4 Apply the legal principles of boundary delimitation in, for example, boundary retracement, water boundaries, sectional title schemes, mineral rights surveys, and surveys on statutory and customary tenure. |

| | |
|---|---|
| | 7.5 Compute property subdivisions and write clear and complete parcel descriptions.<br>7.6 Define land administration problem, its requirements, constraints, and opportunities and then prioritize the requirements in the design of a new land administration system.<br>7.7 Apply your knowledge of land law in an international/national and/or regional scenario. |
| LO8. Demonstrate knowledge and understanding of the techniques for conflict avoidance, conflict management and dispute resolution procedures including for example adjudication and arbitration. | 8.1 Demonstrate understanding and application of processes of alternative dispute resolution (ADR) to resolve land disputes.<br>8.2 Show understanding of the concept of legal pluralism and how it relates to land dispute resolution.<br>8.3 Apply your legal knowledge in a professional scenario (expert witness) such as a minor boundary dispute.<br>8.4 Analyse and classify the different forms of land disputes and identify institutions capable of settling them either formally or informally and ways to cope with land disputes.<br>8.5 Advise courts of mapping issues, explain complex surveying problems (map accuracy for example) to legal professionals.<br>8.6 Show understanding and application of negotiation, mediation, consensus building, adjudication, and arbitration mechanisms in resolving land disputes. |

| ***SECTION C*** | ***QUALIFICATION STRUCTURE*** | | | | |
|---|---|---|---|---|---|
| ***COMPONENT*** | ***TITLE*** | ***Credits Per Relevant NCQF Level*** | | | ***Total*** ***(Per** Subject/ Course/ Module/ Units)* |
| | | ***Level [5]*** | ***Level [6]*** | ***Level [7]*** | |
| ***FUNDAMENTAL COMPONENT*** *Subjects/ Courses/ Modules/Units* | Communication and Academic Literacy Skills | 10 | | | 10 |
| | Computing skills fundamentals | 20 | | | 20 |
| | Academic and Professional Communication | 10 | | | 10 |
| ***CORE COMPONENT*** *Subjects/Courses/ Modules/Units* | Introductory mathematics | 26 | | | 26 |
| | Geometrical optics and mechanics | 14 | | | 14 |
| | Electricity, magnetism, and elements of modern physics | 13 | | | 13 |
| | Geomatics | 14 | 14 | | 28 |
| | Survey camp | | 20 | | 20 |

| | | | | | |
|---|---|---|---|---|---|
| | Engineering mathematics | | 39 | | 39 |
| | Programming principles | | 13 | | 13 |
| | Principles of Cartography | | 11 | | 11 |
| | Elements of Photogrammetry | | 13 | | 13 |
| | Introduction to Planning and Built Environment | | 10 | | 10 |
| | Digital Photogrammetry | | 13 | | 13 |
| | Introduction to Remote Sensing | | 10 | | 10 |
| | Digital Cartography | | 11 | | 11 |
| | Programming for Geomatics | | 11 | | 11 |
| | Industrial Training | | 28 | | 28 |
| | Database Concepts | | 11 | | 11 |
| | Engineering Surveying | | | 13 | 13 |
| | Geodesy | | 22 | | 22 |
| | Land Law for Geomatics | | 10 | | 10 |
| | Survey Adjustment and Analysis | | | 13 | 13 |

| | | | | | |
|---|---|---|---|---|---|
| | Introduction to Land Administration | | 10 | | 10 |
| | Principles of GIS | | 11 | | 11 |
| | Satellite Positioning | | | 11 | 11 |
| | Research Project | | | 28 | 28 |
| | Spatial Data Modelling & Analysis | | | 14 | 14 |
| | Advanced Land Administration | | | 11 | 11 |
| | Cadastral Surveying Principles and Practice | | | 13 | 13 |
| | Geomatics for Mining | | | 11 | 11 |
| | Professional Practice and Ethics | | | 10 | 10 |
| | | | | | |
| | | | | | |
| ***ELECTIVE/ OPTIONAL COMPONENT*** | Digital Image Processing | | | 13 | |
| | Remote Sensing Applications | | | 13 | |

| | | | | | |
|---|---|---|---|---|---|
| *Subjects/Courses/ Modules/Units*<br>**NB: Choose 3 modules to a total of 39 credits** | Advanced Cartographic Visualizations | | | 13 | 13 |
| | Principles and Practice of SDI Development | | | 13 | 13 |
| | GIS Design and Implementation | | | 13 | 13 |
| | Location Based Services | | | 13 | 13 |
| | GIS Applications | | | 13 | 13 |
| | Special Studies in Land Administration | | | 13 | 13 |

| ***SUMMARY OF CREDIT DISTRIBUTION FOR EACH COMPONENT PER NCQF LEVEL*** | |
|---|---|
| ***TOTAL CREDITS PER NCQF LEVEL*** | |
| ***NCQF Level*** | ***Credit Value*** |
| 5 | 107 |
| 6 | 257 |
| 7 | 163 |
| ***TOTAL CREDITS*** | **527** |

***Rules of Combination:***

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

To attain the Bachelor of Geomatics qualification, students must fulfil the requisite learning outcomes in core, options, and general education (GEC) courses as indicated in the section above and summarized below.

At level 400, a student is required to choose two (2) optional courses in semester 1 and one (1) optional course in semester 2, as listed in the table above. In addition, students are required to undergo an experiential learning comprising of eight (8) weeks of industrial training after level 200 and level 300.

| ***ASSESSMENT ARRANGEMENTS*** |
|---|
| • Assessment will include both formative and summative modes.<br>• Formative assessment will contribute 60% to the overall qualification.<br>• Summative assessment will constitute the other 40% of the overall qualification.<br>• Assessment shall be carried out by BQA accredited Assessors in line with institutional and national policies. |
| ***MODERATION ARRANGEMENTS*** |
| • There will be both Internal Moderation and External moderation.<br>• Moderation for assessment shall be carried out by BQA accredited moderators in accordance with the institutional policies and in line with the national policy. |
| ***RECOGNITION OF PRIOR LEARNING*** |
| • RPL will be applicable for award of credits to contribute to the award of the qualification. |
| ***CREDIT ACCUMULATION AND TRANSFER*** |
| • CAT will be applicable for award of credits to contribute to the award of the qualification. |
| ***PROGRESSION PATHWAYS (LEARNING AND EMPLOYMENT)*** |
| **Horizontal Pathways**<br>• Bachelor of Land surveying<br>• Bachelor of Geospatial Sciences<br>• Bachelor of Geoinformatics |

**Vertical pathways**

- Master Science of Land surveying
- Master Science in Photogrammetry and Geoinformatics
- Master Science in Geodesy

**Employment pathways**

- Land Surveyor
- Cartographer
- Photogrammetrist
- Engineering Surveyor
- GIS Specialist

## *QUALIFICATION AWARD AND CERTIFICATION*

**Qualification Award**

- Graduates shall be awarded a Bachelor of Science in Geomatics upon obtaining a minimum of 527 credits.

**Certification**

- There will be issuance of a certificate and an official transcript at award.

## *REGIONAL AND INTERNATIONAL COMPARABILITY*

Comparability is done with 2 regional and 2 international universities. These universities are: University of Cape Town in South Africa; Namibia University of Science and Technology in Namibia; University of Newcastle in Australia; University of Alaska in USA.

**Similarities**

- The structure of the programmes is similar with the first year providing Mathematics and Science courses, followed by Fundamental Geographic Information Systems, Geomatics and Surveying Courses in second year, which includes introductory courses in the disciplines. The penultimate and final years deal with detailed core discipline courses as well as some geospatial data analysis and project aspects in the final year.
- Employability pathways are largely similar.
- Assessment is generally formative for in class tests and summative for final examinations.

**Differences**

- The University of Newcastle, Australia, unlike other universities investigated, offers an honours degree programme at Level 8 (AQF), while others only offer a Level 7 degree (except for The University of Alaska, Anchorage, USA, where there is no qualification framework).
- Unlike other universities investigated, Namibia University of Science and Technology offers a 3-year degree programme, while others its 4 years.
- Qualifications awarded vary. Two universities (University of Cape Town (South Africa) and University of Alaska, Anchorage (USA)) offer a Bachelor of Science Degree award, while the other two (Namibia University of Science and Technology (Namibia) and University of Newcastle (Australia)) offer a Bachelor of Engineering Degree award.

**Summary**

The Bachelor of Geomatics Degree offered by the University of Botswana is largely similar to the ones from South Africa (4 years), USA (4 years) and Australia (4 years), where the structure emphasizes a solid background in Mathematics and Science in the first year of study followed by a good grounding in Geomatics and Surveying, Geographic Information Systems, and Real Property and Survey Law in the following years. For the three-year programme in Namibia, there is less emphasis on Mathematics and Science, and some

aspects of Real and Property Law are missing. The exit level outcomes are similar as well as pathways for further study and career growth.

The Bachelor of Geomatics programme compares very favourably with others from around the continent and the world. Additionally, it is unique in offering a specialized major in cadastral surveying, which presents advantages in relation to the exit level outcomes for the graduate and hopefully places them at an advantage in their career pathways.

***REVIEW PERIOD***

The qualification will be reviewed every 5 years.