QUALIFICATION SPECIFICATION								SECTION A
QUALIFICATION DEVELOPER	University of Botswana							
TITLE	Bachelor of Engineering (Honours) in Industrial Engineering				**NCQF LEVEL**	8		
FIELD	Manufacturing, Engineering and Technology			**SUB-FIELD**	Engineering and Engineering Trades			
New qualification	√	Review of existing qualification						
SUB-FRAMEWORK	General Education		TVET		Higher Education	√		
QUALIFICATION TYPE	Certificate		Diploma		Bachelor			
	Bachelor Honours	√	Master		Doctor			
CREDIT VALUE	638							

RATIONALE AND PURPOSE OF THE QUALIFICATION

The Qualification has been designed to respond to the social and economic needs of Botswana and that of the region, especially in areas that deal with operations research, Manufacturing, entrepreneurship, creativity, innovation, and productivity to provide the society with innovators and Industrial Engineers. The BEng Honours (Industrial) Qualification is designed with an informed, constructive alignment between credit-bearing courses in core engineering knowledge areas, practical skills training, and activities targeting the evolution of appropriate social, cultural, and ecological responsibility among the graduates. It is also aligned to the key strategic sectors of industries; research, innovation, science, and technology; and manufacturing as identified by the Human Resource Development Council (HRDC) which requires a high demand for manpower to transform Botswana into a creative and knowledge-based economy.

The Qualification's core mandate is to train learners to be entrepreneurs and/or occupy positions related to Industrial Engineering in Botswana's manufacturing and service sectors, as well as government departments. It also upgrades students with a Diploma in Mechanical Engineering or related qualifications to a degree level. The qualification has been developed in line with the outcome-based learning principles. The qualification development has been informed by the accreditation requirements of the Engineering Council of South Africa (ECSA) and Botswana Qualification Authority (BQA) which are the accreditation bodies for the Qualification internationally and nationally respectively. The qualification contributes to the strategic role of meeting the country's development needs through advancing human resource development and developing research and innovation capacity (Revised National Policy of Education 1994; Education and Training Sector Strategic Plan, 2015, National Development Plan 11, 2017).

Furthermore, this Qualification is commensurate with three of the pillars *of Vision 2036 (https://statsbots.org.bw/vision-2036-1)* of producing 'sustainable economic development, human and social development and sustainable environment', as well as two key future imperatives of 'innovation and sustainability.

Purpose of the qualification:

The purpose of this qualification is to produce graduates with Knowledge, skills, and competencies to:

- Provide technical and innovative solutions in the field of mechanical engineering.
- Solve a problem, identify, formulate, analyse, and solve complex engineering problems creatively and innovatively.
- Apply knowledge of mathematics, natural sciences, engineering fundamentals and an engineering specialty to solve complex engineering problems.
- Perform creative, procedural, and non-procedural design and synthesis of components, systems, engineering works, products, or processes.
- Demonstrate competence to design and conduct investigations and experiments.
- Demonstrate competence to use appropriate engineering methods, skills, and tools, including those based on information technology.
- Demonstrate critical awareness of the need to act professionally and ethically and to exercise judgment and take responsibility within own limits of competence.
- Demonstrate competence to work effectively as an individual, in teams and in multidisciplinary environments.

(ENTRY REQUIREMENTS (including access and inclusion)

- Minimum of Certificate IV, NCQF Level 4 (General Education or TVET) with at least 20 credits at NCQF level 5.
- There shall be provision for entry through Recognition of Prior Learning (RPL) and Credit Accumulation and Transfer (CAT) in line with institutional and national policies.

QUALIFICATION SPECIFICATION SECTION B	
GRADUATE PROFILE (LEARNING OUTCOMES)	**ASSESSMENT CRITERIA**
1. Apply knowledge of mathematics, basic science, and engineering sciences from first principles to solve engineering problems.	1.1 Identify and solve open-ended engineering problems. 1.2 Identify and pursue engineering applications. 1.3 Work across engineering disciplinary boundaries through cross disciplinary literacy and shared fundamental knowledge.
2. Demonstrate competence to identify, assess, formulate, and solve *convergent* and *divergent* engineering problems creatively and innovatively.	2.1 Analyze and define the problem, identify the criteria for an acceptable solution. 2.2 Identify necessary information and applicable engineering and other knowledge and skills. 2.3 Generate and formulate possible approaches to solution of problem. 2.4 Model and analyse possible solution(s). 2.5 Evaluate possible solutions and select best solution. 2.6 Formulate and present the solution in an appropriate form.
3. Perform creative, procedural, and non-procedural design and synthesis of components, systems, engineering works, products, or processes.	3.1 Identify and formulate the design problem to satisfy user needs, applicable standards, codes of practice and legislation. 3.2 Plan and manage the design process: focus on important issues, recognise and deal with constraints. 3.3 Acquire and evaluate the requisite knowledge, information and resources: apply correct principles, evaluate and use design tools. 3.4 Perform design tasks including analysis, quantitative modelling, and optimization. 3.5 Evaluate alternatives and preferred solution and exercise judgment, test implementability and perform techno-economic analysis. 3.6 Assess impact and benefits of the design: social, legal, health, safety, and environmental. 3.7 Communicate the design logic and information.

4. Demonstrate competence to design and conduct investigations and experiments.	4.1 Plan and conduct investigations and experiments. 4.2 Conduct a literature search and critically evaluate material. 4.3 Perform necessary analysis. 4.4 Select and use appropriate equipment or software. 4.5 Analyse, interpret and derive information from data. 4.6 Draw conclusions based on evidence. 4.7 Communicate the purpose, process, and outcomes in a technical report.
5. Use appropriate engineering methods, skills, and tools, including those based on information technology.	5.1 Select and assess the applicability and limitations of the method, skill, or tool. 5.2 Properly apply the method, skill, or tool. 5.3 Critically test and assess the end-results produced by the method, skill, or tool. 5.4 Create computer applications as required by the discipline.
6. Demonstrate subject specific skills through hands on engagement in Mechanical engineering	6.1 Use appropriate equipment and tools in designing products, services, and systems. 6.2 Handle and manipulate appropriate materials and technologies in designing products, systems, and services. 6.3 Apply simulation-based methodologies to optimize factory conditions.
7. Demonstrate competence to work effectively as an individual, in teams and in multidisciplinary environments.	7.1 Identifying and executing tasks effectively 7.2 Make individual contribution to team activity
8. Communicate effectively, both orally and in writing, with engineering audience and the community at large.	8.1 Use structure, style, and language appropriate for purpose and audience. 8.2 Use effective graphical support. 8.3 Use appropriate structure, style, and language. 8.4 Use appropriate visual materials. 8.5 Deliver fluently. 8.6 Meet the requirements of the intended audience.
9. Demonstrate discipline specific responsibilities relevant to society.	9.1 Apply discipline specific knowledge to solve societal, health, safety, legal and cultural problems.

	9.2 Show awareness of consequent responsibilities relevant to engineering practice.
10. Apply ethical principles and commit to professional ethics, responsibilities, and norms of engineering technology practice.	10.1 Apply professional ethics and responsibilities and norms of engineering practice. 10.2 Take responsibility for own work, use of resources, and accountability for own decisions and actions. 10.3 Apply ethical considerations when designing sustainable products, services, and systems and also while doing assignments, projects, tests and examinations. 10.4 Identify and address ethical issues based on critical reflection on the suitability of different ethical value systems to specific contexts.
11. Interact with the planet to maintain natural resources	11.1 Accept responsibility of impact of engineering solutions in a societal context. 11.2 Understand the need for sustainable development.
12. Demonstrate the knowledge of business management and finance.	12.1 Show knowledge of management and business practices, such as risk and change management, and understand their limitations.
13. Engage in independent and lifelong learning through well-developed learning skills.	13.1 Recognize the need for and have the ability to engage in independent and lifelong learning.

QUALIFICATION STRUCTURE SECTION C			
FUNDAMENTAL COMPONENT Subjects / Units / Modules /Courses	**Title**	**Level**	**Credits**
	Engineering Mathematics 1	6	12
	Materials Science for engineers	7	13
	Engineering Mechanics: Statics	7	13
	Workshop Technology	7	12
	Electrical fundamentals 1	6	13
	Engineering and Computer Aided Drawing	7	12
	Engineering Mathematics 2	7	12
	Mechanics of Materials	7	13
	Workshop Technology	7	12
	Manual and Computer Aided Drafting	7	12
	Dynamics of particles	7	13
	Electrical fundamentals 2	7	13
	Introduction to Accounting	7	13
	Industrial Training	7	40
CORE COMPONENT Subjects / Units / Modules /Courses	Introduction to Mathematical Statistics	8	12
	Foundations of Business Law	8	9
	Engineering Materials	8	13
	Engineering Economics	8	10
	Principle of Management	8	9
	Information System Design	8	13
	Industrial Logistics	8	13
	Manufacturing Processes	8	13
	Operations Research I	8	13
	Principles of Marketing	8	13
	Cost Accounting	8	13
	Operations Research II	8	15
	Simulation Modelling	8	13
	Manufacturing Systems	8	13
	Computer Programming	8	13
	Process Planning and Cost Estimation	8	13

	Industrial Quality Control	8	13
	Productivity and Technology Management	8	13
	Organizational Ergonomics	8	13
	Technological Entrepreneurship	8	13
	Industrial Training	8	40
	Project I	8	24
	Facilities Planning and Value Engineering	8	13
	Project II	8	24
	Professional Ethics	8	13
	Production and Operations Management	8	13
ELECTIVE COMPONENT Subjects / Units / Modules /Courses	**Electives Set 1 (Choose 2 from this set)**		
	Production Planning and Control	8	13
	Cost and Management Accounting	8	
	Computer Aided Manufacturing	8	
	Electives Set 2 (Choose 2 from this set)		
	Industrial Relations	8	
	Project Management	8	
	Environmental Engineering	8	13
	Industrial Analysis	8	

Rules of combinations, Credit distribution (where applicable):

The Bachelor of Engineering (Industrial) degree is composed of Industrial engineering courses. To attain this qualification, students should fulfil the requisite learning outcomes in fundamental, core, and electives courses. Learners will choose two (2) courses from the first three (3) elective courses (in blue colour), which is equivalent to 26 credits (2 x 13). Similarly, Learners will choose two (2) courses from subsequently four selective courses (in red colour), which is equivalent to 26 credits (2 x13).

Credit distribution

Total number of credits at the exit level (Level 8) 435

Level 6 25

Level 7 178

Total Credits = 638

The credit combination for this qualification is from 203 fundamental components, 377 core components and the remaining 52 is from elective components where the candidates must choose any two.

MODERATION ARRANGEMENTS

Formative assessment

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

The contribution of formative assessment to the final grade is 40%

Summative assessment

The contribution of summative assessment to the final grade is 60%

Moderation requirements

Both internal and external moderation shall be done in accordance with applicable policies and regulations and shall be carried out by registered and accredited moderators.

RECOGNITION OF PRIOR LEARNING (if applicable)

There will be provision of awarding this qualification through Recognition of Prior Learning and Credit accumulation and Transfer in line with BQA RPL policy and the well-established ETP RPL Policy.

PROGRESSION PATHWAYS (LEARNING AND EMPLOYMENT)

Horizontal Articulation (related qualifications of similar level that graduates may consider):

- BEng Manufacturing Engineering
- BEng Industrial and Manufacturing Engineering
- BEng Production Engineering
- BEng Industrial and Systems Engineering

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

- MSc Industrial Engineering
- MEng Industrial Engineering
- MSc Manufacturing Systems
- MEng Engineering Management
- MPhil Industrial Engineering

Diagonal pathways (qualifications to which the holder may progress to):

- MEng Logistics and Supply chain management
- MSc Project Management

Employment pathways:

- Industrial Engineer

- Engineering managers
- Industrial production manager
- Quality control manager
- Management analyst
- Quality control inspector
- Cost estimators
- Logistics and supply chain manager
- Operations manager
- Industrial design engineer
- Business process analyst and
- Independent consultant.

QUALIFICATION AWARD AND CERTIFICATION

A candidate is required to achieve the stipulated **638** total credits inclusive of the fundamental, core and elective components, to be awarded Bachelor of Engineering (Honours) in Industrial Engineering qualification.

Certification

Upon completion of the qualification, the candidate will be awarded a Bachelor of Engineering (Honours) in Industrial Engineering.

REGIONAL AND INTERNATIONAL COMPARABILITY

BEng (Industrial) Qualification is common in engineering faculties both locally and internationally. The Department examined current Qualification with similar Qualifications internationally to incorporate best practices. Regionally, the department benchmarked with similar Qualifications from the University of Pretoria, University of Stellenbosch, Concordia University (Canada) and West Virginia University (USA).

University of Pretoria (South Africa) offers a Bachelor of Engineering in Industrial Engineering (NQF Level 8: 588 Credits). The exit learning outcomes include: Apply engineering principles to systematically diagnose and solve broadly defined engineering problems, Demonstrate the application of mathematical, science and engineering knowledge in an engineering environment, Perform procedural and non-procedural design of broadly defined components, systems, works, products or processes to meet desired needs within applicable standards, codes of practice and legislation, Communicate technical, supervisory and general management information effectively, both orally and in writing, using appropriate language

and terminology, structure, style and graphical support, Apply engineering management principles and concepts to engineering activities, Demonstrate a critical awareness of the impact of engineering activity on the social, industrial and physical environment, and of the need to act professionally within own limits of competence. Assessment strategies include: portfolios, industrial attachment reports, assessments, written examinations, oral examinations, peer assessment, research report, and project report etc. The qualification is awarded to candidates who have achieved the learning outcomes and satisfied the assessment criteria as well as passing an external examined research project. The employment pathways include, being industrial engineers and researchers in the same field.

Stellenbosch University offers a 4-year Bachelor of Engineering in Industrial Engineering (NQF level 8), 580 Credits. The exit learning outcomes include: Apply engineering principles to systematically diagnose and solve broadly defined engineering problems, Demonstrate the application of mathematical, science and engineering knowledge in an engineering environment, Perform procedural and non-procedural design of broadly defined components, systems, works, products or processes to meet desired needs within applicable standards, codes of practice and legislation, Communicate technical, supervisory and general management information effectively, both orally and in writing, using appropriate language and terminology, structure, style and graphical support, Apply engineering management principles and concepts to engineering activities, Demonstrate a critical awareness of the impact of engineering activity on the social, industrial and physical environment, and of the need to act professionally within own limits of competence. Assessment strategies include: portfolios, industrial attachment reports, assessments, written examinations, oral examinations, peer assessment, research report, and project report etc. The qualification is awarded to candidates who have achieved the learning outcomes and satisfied the assessment criteria as well as passing an external examined research project. The employment pathways include, being industrial engineers and researchers in the same field.

Concordia University (Canada) offers a Bachelor of Engineering (Industrial Engineering) programme, and the total credits are 120 (Ontario Qualifications Framework (OQF) Level 10). The generic competencies that the holder of qualification is expected to be able to demonstrate, with a focus on knowledge and skills transferable to the workplace or useful for further study. The capacity to work creatively and autonomously is required at all levels but in contexts that range from fixed routines to those characterized by ambiguity and uncertainty. The qualification standard is based on Depth and Breadth of Knowledge, Conceptual & Methodological Awareness / Research and Scholarship, Communication Skills, Application of Knowledge, Professional Capacity/Autonomy. Awareness of Limits of Knowledge. Assessment methods used are: Tests and course work; professional experience placement and curriculum and assessment. The minimum

standards for the award of the qualification include satisfying the outlined learning outcomes and completion of professional placements. The employment pathways comprise: working in public and private Industries/ organizations.

West Virginia University (USA) offers a Bachelor of Science (Industrial Engineering) programme and the total credits are 129. The industrial engineering program is accredited by the Engineering Accreditation Commission (EAC) of ABET. The generic competencies that the holder of qualification upon graduation will have acquired the: Ability to use modern and classical industrial engineering methodologies such as operations research, manufacturing systems, computer programming and simulation, production systems, human factors and ergonomics, engineering statistics and quality control, and engineering economics. Ability to apply knowledge of math, science, and general engineering. Ability to design and conduct experiments, analyze and interpret data, develop implementation strategies, and shape recommendations so that results will be achieved, and findings will be communicated effectively. Ability to work individually, on teams, and on multi-disciplinary teams to identify, formulate, and solve problems using industrial engineering knowledge, skills, and tools. Ability to design and implement or improve integrated systems that include people, materials, information, equipment, and energy using appropriate analytical, computational, and experimental practices. Broad education necessary to develop and maintain professional ethics and understand the comprehensive impact of their solutions on individuals and the society. Recognition of the need for and an ability to engage in life-long learning. Professional characteristics expected of a successful industrial engineer. The minimum standards for the award of the qualification include satisfying the outlined learning outcomes and completion of professional placements. The employment pathways comprise secondary school teaching; teaching/training in community and working in private organizations.

Similarities:
The main similarities observed include teaching and delivery of Industrial engineering courses, to prepare candidates for the following: professional practice in industry, working in community projects and becoming board members. The assessment criteria cover a wide array, from tests and examinations to industrial live projects and industrial placement. The proposed qualification is quite comparable with the examined qualifications. It is tailor made to prepare candidates to be working in manufacturing and services sectors in Botswana, but with added skillsets which would allow the candidates to practice and work as researchers in Industrial engineering environment. The assessment criteria are like the other qualifications. The proposed qualification has an added advantage that it equips graduates with skills to venture into

entrepreneurship. During the student's study period, there are given an opportunity to go to internship to a wide variety of industries. Therefore, the programme builds a holistic, and versatile graduates.

Differences:

Current qualification has NQF level 8 with 632 credits, while University of Pretoria has NQF Level 8: 588 Credits; Stellenbosch University offers a 4-year Bachelor of Engineering in Industrial Engineering, NQF level 8, 580 Credits. Concordia University (Canada) offers a Bachelor of Engineering (Industrial Engineering) Qualification, and the total credits are 120 (Ontario Qualifications Framework (OQF) Level 10). West Virginia University (USA) offers a Bachelor of Science (Industrial Engineering) Qualification, and the total credits are 129. Information on assessments is not available for all bench marking programmes, but the current qualification is assessed in terms of tests, assignments, quizzes, mini-projects, projects and oral presentations.

REVIEW PERIOD

Every 5 years