QUALIFICATION SPECIFICATION ✓ SECTION A			
QUALIFICATION DEVELOPER	Botswana International University of Science & Technology		
TITLE	Bachelor of Engineering (Honours) Industrial and Manufacturing Engineering	**NCQF LEVEL**	8
FIELD	Manufacturing, Engineering and Technology	**SUB-FIELD**	Industrial and Manufacturing Engineering

New qualification	✓	Review of existing qualification					
SUB-FRAMEWORK	General Education		TVET		Higher Education		✓
QUALIFICATION TYPE	Certificate		Diploma		Bachelor		
	Bachelor (Honours)	✓	Master		Doctor		
CREDIT VALUE					630		

RATIONALE AND PURPOSE OF THE QUALIFICATION

A study of the Botswana's eleventh national development plan (NDP 11) demonstrates a lack of industrial & manufacturing engineers who are required to achieve her vision of transformation to a knowledge-based economy by moving from a traditionally product driven market to a services market (National Development Plan 11, [NDP11, 2017]). At present, it is estimated that Botswana has an average of one engineer per ten thousand citizens while she still imports expatriate engineers annually to support her local industries. Moreover, the effort by Botswana government to minimise the skills shortage in the field of industrial and manufacturing engineering by sending her citizens to foreign Universities for training has cost her at least three million Pula sponsorship per person. It is also pertinent to note that the training that Batswana have received in the foreign Universities have not been tailored to meet the needs of Botswana local industries. The Bachelor of Engineering (B.Eng.) qualification in industrial & manufacturing engineering at Botswana International University of Science & Technology (BIUST) is proposed to have a strong focus on industrial & manufacturing systems and processes so as to ensure that graduates are adequately exposed to the concepts, tools, and techniques that will be required to effectively function as industrial & manufacturing engineers within the Botswana economy. Labour

surveys conducted by the Human Resource & Development Council (HRDC) and Statistics Botswana also found that majority of manufacturing firms in Botswana find it extremely difficult in finding engineering graduates with appropriate skills in managing their firms. Hence, the government of Botswana through (National Development Plan 11, [NDP11, 2017]) mandated universities to produce people with those skills with industrial and manufacturing engineering being listed among the top ten scarce skills in the Southern African Development Community (SADC). Therefore, BIUST B. Eng. industrial & manufacturing engineering curriculum is aligned to 11th national development plan (NDP 11) and vision 2036 which aims to engage training in modern and environment friendly manufacturing processes in developing engineers required to achieve Botswana's vision of transformation to a knowledge-based economy (NDP 11, 2017; Top Occupations in High Demand," HRDC, 2016; BIUST Strategic Plan 2016-2022, 2016).

The purpose of this qualification is to produce graduates with requisite skills in product/process design & development, production systems and equipment design, automated systems and control, quality, project management/concurrent engineering, computer skills, communication skills, interpersonal/teamwork.

This qualification will produce graduates with highly specialised knowledge, skills, and competence to:

- Demonstrate highly specialised knowledge in Industrial and Manufacturing Engineering involving critical analysis and independent evaluation of qualitative and quantitative data.
- Manage functions and processes, carry out basic research, critical evaluation and synthesis of ideas, issues, and concepts, capacity to identify and solve complex and unpredictable problems.
- Apply a range of advanced specialist knowledge and skills in Industrial and Manufacturing Engineering with a sense of identification with, and integrity of the profession and exercises autonomy, initiative and authority and takes responsibility and accountability for own work output and of others in the discipline of Industrial and Manufacturing Engineering.

ENTRY REQUIREMENTS (including access and inclusion)

***Minimum Formal Entry Qualifications*:**

- Certificate IV, NCQF level 4 equivalent.

- Candidates who do not meet the above requirements will be considered for admission through Recognition of Prior Learning (RPL) and Credit Accumulation & Transfer (CAT) in accordance with the policy of each individual Educational Training Provider (ETP's)

QUALIFICATION SPECIFICATION	**SECTION B**
GRADUATE PROFILE (LEARNING OUTCOMES)	**ASSESSMENT CRITERIA (EVIDENCE DURING PRACTICE)**
LO 1 Apply systematic problem-solving method to solve convergent and divergent engineering problems creatively and innovatively.	1.1. Identify the criteria for an acceptable solution to an engineering problem. 1.2. Analyse necessary information and applicable engineering knowledge and skills and define possible approaches to solution of problem. 1.3. Generate possible solution(s) to an engineering problem. 1.4. Formulate best solution to the engineering problem. 1.5. Present the solution in an appropriate form
LO 2: Apply knowledge of mathematics, basic science, and engineering sciences from first principles to solve complex engineering problems.	2.1 Brings mathematical, numerical analysis and statistical knowledge and methods to solve engineering problems by using an appropriate mix of: 2.1.1 Critical analysis and model of engineering components, systems, or processes. 2.1.2 Communicate concepts, ideas, and theories with the aid of mathematics.

	2.1.3 Reason about and conceptualise engineering components, systems or processes using mathematical concepts. 2.1.4 Deal with uncertainty and risk through the use of probability and statistics. 2.2 Uses physical laws and knowledge of the physical world as a foundation for the engineering sciences and the solution of engineering problems by an appropriate mix of: 2.2.1 Critical analysis and model of engineering components, systems or processes using principles and knowledge of the basic sciences. 2.2.2 Reason about and conceptualise engineering problems, components, systems or processes using principles of the basic sciences. 2.3. Uses the techniques, principles, and laws of engineering science at a fundamental level and in at least one specialist area to: 2.3.1 Identify and solve open-ended engineering problems. 2.3.2 Identify and pursue engineering applications. 2.3.3 Work across engineering disciplinary boundaries through cross disciplinary literacy and shared fundamental knowledge.
LO3 Design engineering components, systems, engineering works, products, or processes.	3.1 The graduate carries out an acceptable design process encompassing the following in Industrial and Manufacturing Engineering: 3.1.1 Identify and formulate the design problem to satisfy user needs, applicable standards, codes

	of practice and legislation. 3.1.2 Plan and manage the design process and focusses on important issues, recognize, and deal with constraints. 3.1.3 Acquire and evaluate the requisite knowledge, information, and resources: apply correct principles, critically evaluate, and use design tools. 3.1.4 Perform design tasks including analysis, quantitative modelling, and optimization. 3.1.5 Critically evaluate alternatives and preferred solution: exercise judgment, test implementability and perform techno-economic analyses. 3.1.6 Assess impacts and benefits of the design: social, legal, health, safety, and environmental. 3.1.7 Communicate the design logic and information
LO4 Design and conduct Industrial and Manufacturing Engineering investigations and experiments.	4.1 The graduate carries out an acceptable process in Industrial and Manufacturing Engineering including but not restricted to: 4.1.1 Plan and conduct investigations and experiments. 4.1.2 Conduct a literature search and critically evaluate material. 4.1.3 Perform necessary analyses. 4.1.4 Select and use appropriate equipment or software. 4.1.5 Critically analyse, interpret, and derive information from data. 4.1.6 Draw conclusions based on evidence. 4.1.7 Communicate the purpose, process, and outcomes in a technical report
LO5	5.1. Use method, skill, or tool effectively to:

Critically create, select, and apply appropriate engineering methods, skills, and tools, including those based on information technology.	5.1.1 Select and assess the applicability and limitations of the method, skill, or tool. 5.1.2 Apply the method, skill, or tool. 5.1.3 Critically test and assess the end-results produced by the method, skill, or tool. 5.2. Create computer applications as required by the Industrial and Manufacturing Engineering discipline.
LO6 Communicate engineering technical information effectively orally and in writing, with engineering audiences and the community at large.	6.1 The graduate carries out effective written communication of Industrial and Manufacturing Engineering information as evidenced by: 6.1.1 Use of appropriate structure, style and language for purpose and audience. 6.1.2 Use of effective graphical support. 6.1.3 Apply methods of providing information for use by others involved in engineering activity. 6.1.4 Effective oral communication, use of appropriate structure, style, language, visual materials and delivering fluently to meet the requirements of the intended audience.
LO7 Demonstrate critical awareness of the impact of engineering activity on the social, industrial, and physical environment.	7.1 The graduate identifies and deals with an appropriate combination of issues in: 7.1.1 The impact of technology on society. 7.1.2 Occupational and public health and safety. 7.1.3 Impacts on the physical environment. 7.1.4 The personal, social, cultural values and requirements of those affected by engineering activity.
LO8	8.1 The graduate demonstrates effective individual work by performing the following: 8.1.1. Identify and focus on objectives. 8.1.2. Work strategically.

Work effectively as an individual, in teams and in multidisciplinary environments in Industrial and Manufacturing Engineering	8.1.3. Execute tasks effectively. 8.1.4. Deliver completed work on time. 8.2 The graduate demonstrates effective teamwork by the following: 8.2.1. Make individual contribution to team activity. 8.2.2. Perform critical functions. 8.2.3. Enhance work of fellow team members. 8.2.4. Benefit from support of team members. 8.2.5. Communicate effectively with team members. 8.2.6. Deliver completed work on time. 8.3 The graduate demonstrates multidisciplinary work by the following: 8.3.1. Acquire a working knowledge of co-workers' discipline. 8.3.2. Use a system approach. 8.3.3. Communicate across disciplinary boundaries.
LO9 Engage in independent learning through well-developed learning skills	The graduate shows evidence of being an effective independent learner by the following: 9.1. Reflect on own learning and determine learning requirements and strategies. 9.2. Source and evaluate information. 9.3. Access, comprehend and apply knowledge acquired outside formal instruction. 9.4. Critically challenge assumptions and embrace new thinking
LO10 Act professionally and ethically to exercise judgment and take responsibility within own limits of	The graduate demonstrates professionalism by the following: 10.1. Being aware of requirements to maintain continued competence and to keep abreast of up-to-date tools and techniques.

competence in Industrial and Manufacturing Engineering.	10.2. Display understanding of the system of professional development. 10.3. Accept responsibility for own actions. 10.4. Display judgment in decision making during problem solving and design. 10.5. Limit decision making to area of current competence. 10.6. Reason about and make judgment on ethical aspects in case study context. 10.7. Discern boundaries of competence in problem solving and design 10.8. Develop specialized understanding of the legal, practical and regulatory requirements of health, safety, legal processes, guidelines and consequent responsibilities relevant to industrial and manufacturing engineering practice
LO11 Apply highly specialized knowledge and understanding of engineering management principles and economic decision-making	The graduate 11.1. Demonstrate awareness of fundamental knowledge of project management activities for all project management functions during each life cycle phase 11.2. Apply knowledge of project management activities effectively for all project management functions during each life cycle phase 11.3. Accept responsibility for own actions during project management. 11.4. Display judgment in decision making during project management activities. 11.5. Limit decision making to area of current competence; in project management.
LO12	A. The graduate demonstrates ability to: 12.1. Select appropriate methodologies

A Design, select and apply appropriate research methods to solve problems as well as engage and critique current research practices and techniques.	12.2. Collect accurate and relevant data 12.3. Critically evaluate, discuss, and present recent literature and the results 12.4. Compare theoretical predictions with published data 12.5. Evaluate the significance of the results in context. 12.6 Reflect on the implications of the findings on the problem under consideration 12.7. Analyse results of an experiment or other type of research investigation 12.8. Draw valid conclusions and evaluate the level of uncertainty in the results as well as expected outcomes 12.9. Relate recommendations to the research problem are proposed. 12.10. Use analytical ability to manipulate precise and intricate ideas to construct logical arguments. 12.11. Perform scientific experiments or other types of research investigation which produce meaningful results. 12.12. Undertake appropriate analysis of the data 12.13. Discuss results are discussed in terms of published scientific literature and present it in the form of a written dissertation.

QUALIFICATION STRUCTURE SECTION C			
FUNDAMENTAL COMPONENT Subjects / Units / Modules /Courses	**Title**	**NQF Level**	**Credits**
	Component Total Credit		
	General Chemistry I	5	12
	Pre-Calculus	5	12
	Introductory Physics I	5	12
	General Chemistry II	5	12
	Introductory Calculus	5	12
	Introductory Physics II	5	12
	Introduction to Statistics	5	12
	Technical Writing & Academic Literacy	5	6
	Introduction to Engineering*	6	6
	Workshop Practice*	6	12
	Introduction to Computing	5	12
	Engineering Graphics*	6	12
	Total		132
CORE COMPONENT Subjects / Units / Modules /Courses	**Core Component**		
	Technical Report Writing*	6	6
	Procedural Programming*	6	12
	Fundamentals of Electrical I**	6	12
	Engineering Mathematics I*	6	12
	Engineering Mechanics I (Statics)**	6	12
	Materials Science**	6	12
	Object Oriented Programming*	6	12
	Fundamentals of Electrical II**	6	12
	Engineering Mathematics II*	6	12
	Design Methods**	6	6
	Strength of Materials**	6	12
	Engineering Mechanics II (Dynamics)**	6	12
	Total		132

	Engineering Mathematics III	7	12
	Fundamentals of Industrial Engineering & Ergonomics	7	12
	Industrial Statistics & Quality Management	7	12
	Materials & Manufacturing Properties	7	12
	Technical Communication & Basic Research Methods	7	12
	Management & Entrepreneurship: Concept & Principles	7	6
	Engineering Project Management	7	12
	Engineering Mathematics IV	7	12
	Manufacturing Systems Engineering	7	12
	Manufacturing Technology I	7	12
	Operation Research	7	12
	Starting and Sustaining a Business	7	6
	Total		132
	Economics, Business & Entrepreneurship	8	12
	Industrial Systems, Operations & Services	8	12
	Design for Manufacturing	8	12
	Manufacturing Technology II	8	12
	Materials & Product Characterisation	8	12
	Developing a Strategic Business Plan	7	6
	Work Integrated Learning Industrial Attachment	7	36
	Total		102
	Mechanical, Energy & Industrial Engineering Design Research Project	8	36
	Professional Practices, Ethics & Engineering Law	8	12
	Reliability & Maintenance Engineering	8	12

	Technology & Innovation Management	8	12
	Engineering Business & Society	8	12
ELECTIVE COMPONENT Subjects / Units / Modules /Courses	**Elective Component (48 Credits to be selected on the basis of specialization)**		
	Advanced Manufacturing Processes	8	12
	Contemporary Issues in Manufacturing	8	12
	Manufacturing Systems Modelling & Simulation	8	12
	Manufacturing Strategy	8	12
	Emerging Manufacturing Materials	8	12
	Computer Integrated Manufacturing	8	12
	System Application Process/Enterprise Resource Planning (ERP/SAP)	8	12
	Engineering Supply Chain Design & Methods	8	12
	Total		132

RULES OF COMBINATIONS, CREDIT DISTRIBUTION (where applicable):

This qualification is worth a total of **630 credits,** and it comprises of **102 Credits (NQF Level 5 Fundamentals*), 162 credits (NQF Level 6**)**, **178 credits (NQF Levels 7) 192 (Level 8)** core and **48 credits elective components (NQF Level 8)**

MODERATION ARRANGEMENTS

ASSESSMENT

All assessments, formative and summative, leading/contributing to the award of credits or a qualification should be based on learning outcomes and/or sub-outcomes.

Formative assessment

Formative assessment or continuous assessment contributing towards the award of credits should be based on course outcomes. This can include tests, assignments, and projects as well as simulated and real work settings. The contribution of formative assessment to the final grade shall be 50%.

Summative assessment

Candidates may undergo assessment including written and practical and simulated projects. The final examination for the qualification contributes 50% of the final mark for that course. To pass a course, a candidate must achieve a minimum of 50%.

MODERATION

The following shall apply for both internal and external moderation in accordance with applicable institutional policies and regulations:

Provision for internal and external moderation (QA): Assessors and moderators possess BQA accreditation status. Details as spelt out in institutional policy.

RECOGNITION OF PRIOR LEARNING & CAT (if applicable)

Candidates may submit evidence of prior learning and current competence and/or undergo appropriate forms of RPL & CAT assessment for the award of credits towards the qualification in accordance with applicable RPL policies and relevant national-level policy and legislative framework.

PROGRESSION PATHWAYS (LEARNING AND EMPLOYMENT)

LEARNING PATHWAYS

Horizontal articulation

- BEng (Honours) Mechanical and Energy Engineering
- BEng (Honours) Mechatronics & Industrial Instrumentation

- BEng (Honours) Materials & Metallurgical Engineering
- BEng (Honours) Production Engineering
- BEng (Honours) Industrial Engineering
- BEng (Honours) Manufacturing Engineering

Vertical articulation

- MEng Industrial Engineering
- MEng Manufacturing Engineering
- MEng Mechanical Engineering
- MEng Materials & Metallurgical Engineering
- MEng Production Engineering

EMPLOYMENT PATHWAYS

- Materials & Metallurgical Engineers
- Project Managers
- Industrial Engineers
- Quality Assurance Engineers
- Manufacturing Engineers
- Maintenance Engineers
- Reliability Engineers
- Asset Management Engineers
- Mechanical Design Engineers
- Researchers

QUALIFICATION AWARD AND CERTIFICATION

Award:

Candidates who meet the minimum 630 credits will be awarded B.Eng. (Industrial & Manufacturing Engineering).

Certification

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

REGIONAL AND INTERNATIONAL COMPARABILITY

University of Cambridge (UK National Qualifications Framework Bachelor of Arts (Manufacturing Engineering NQF Level 6): This qualification provides a sound theoretical basis in manufacturing technology, manufacturing engineering and business management, coupled with the repeated experience of putting theory into practice via a series of projects. Assessment strategies for this qualification emphasize Integrated approaches and include simulations, on the job assessment, case studies, role plays and provision of RPL. Analysis and problem-solving skills are assessed through a combination of written examinations, coursework reports and project deliverables, in which the criteria include the quality of analysis that has gone into the project solution. Graduates for this qualification may pursue M. Eng. & PhD degrees. Graduates follow a wide range of career paths, including starting companies, designing products, developing technologies, running a factory, advising companies and governments, working in banking and finance and pursuing academic research.

University of Pretoria (Bachelor of Engineering (Honours) in Industrial Engineering NQF Level 7: worth 588 credits):
This qualification is intended to develop knowledge, skills, and competences in (a) Engineering problem solving. (b). Application of specialist and fundamental knowledge, with specific reference to mathematics, basic sciences, and engineering sciences. (c). Engineering design and synthesis. (d). Investigation, experimentation, and data analysis. (e). Engineering methods, skills, tools, and information technology. (f). Professional and general communication. (g). Awareness and knowledge of the impact of engineering activity on society and the physical environment. (h). Work in teams and in multidisciplinary environments. (i). An awareness and ability for lifelong learning. (j). An awareness and knowledge of principles of professional ethics and practice. For upgrading graduates may pursue qualifications at Masters & PhD levels. Assessment strategies for this qualification include Practical assessments
Individual and group projects, Coursework, Written exams and Presentations Learning outcomes provided reflect that both knowledge based and performance-based assessment are applicable.

University of Malaya (Malaysia) Malaysian Qualifications Agency Bachelor of Mechanical Engineering (Manufacturing Engineering) worth 143 credits): This qualification is intended to develop knowledge, skills and competences in (a) Engineering problem solving. (b). Application of specialist and fundamental

knowledge, with specific reference to mathematics, basic sciences, and engineering sciences. (c). Engineering design and synthesis. (d). Investigation, experimentation, and data analysis. (e). Engineering methods, skills, tools, and information technology. (f). Professional and general communication. (g). Awareness and knowledge of the impact of engineering activity on society and the physical environment. (h). Work in teams and in multidisciplinary environments. (i). An awareness and ability for lifelong learning. (j). An awareness and knowledge of principles of professional ethics and practice. Candidates are required to achieve a minimum of 143 credits inclusive of University Compulsory Courses (16 credits); University elective courses (outside Faculty) (4 credits); University co-curriculum (2 credits); Faculty core courses (22 credits); Faculty elective courses (2 credits); Programme compulsory courses (66 credits) & Programme elective courses (31 credits). Assessment strategies for this qualification emphasize Practical assessments; Individual and group projects; Coursework; Written exams and Presentations.

Generally, the qualifications summarized above are similar in that all of them cover manufacturing processes & technology, materials science & engineering, design for manufacturing, engineering management, manufacturing tools and equipment as well as compliance with regard to safety and safe work practices. The qualifications are also expressed in outcome-based terms and are credit based with exception of Cambridge's. All the mentioned qualifications also recognize evidence of prior learning. The proposed qualification generally compares well with the three qualifications studied in terms of content scope and learning hours to be achieved before assessment.

REVIEW PERIOD

This qualification shall be reviewed every five years.

Other information – please add any supplementary information to help the application for this qualification for NCQF Registration.