



COUNCIL ON HIGHER EDUCATION

**Higher Education Qualifications
Sub-Framework**

Qualification standard

for

**Bachelor of Engineering
Technology**

DRAFT FOR COMMENT

The process of drafting this standard is described in the Introduction.

14 February 2017

The Council on Higher Education (CHE) is an independent statutory body established by the Higher Education Act, no. 101 of 1997 (amended). The CHE is the Quality Council for Higher Education, advises the Minister of Higher Education and Training on all higher education issues and is responsible for quality assurance and promotion through the Higher Education Quality Committee.

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HIGHER EDUCATION QUALIFICATIONS SUB-FRAMEWORK

STANDARDS DEVELOPMENT: POLICY AND PROCESS

Introduction

In terms of the National Qualifications Framework (NQF) Act, 67 of 2008, the Council on Higher Education (CHE) is the Quality Council (QC) for Higher Education. The CHE is responsible for quality assurance of higher education qualifications.

Part of the implementation of the Higher Education Qualifications Sub-Framework (HEQSF) is the development of qualification standards. Standards development is aligned with the *nested approach* incorporated in the HEQSF. In this approach, the outer layer providing the context for qualification standards are the NQF level descriptors developed by the South African Qualifications Authority (SAQA) in agreement with the relevant QC. One of the functions of the QC (in the case of higher education, the CHE) is to ensure that the NQF level descriptors ‘remain current and appropriate’. The development of qualification standards for higher education therefore needs to take the NQF level descriptors, as the outer layer in the *nested approach*, into account. An ancillary function is to ensure that they ‘remain current and appropriate’ in respect of qualifications awarded by higher education institutions.

A secondary layer for the context in which qualification standards are developed is the HEQSF. This framework specifies the types of qualification that may be awarded and, in some cases, the allowable variants of the qualification type. An example of variants is the provision for two variants of the Master’s degree (including the ‘professional’ variant). Another example is the distinction, in the Bachelor’s degree type, between the ‘general’ and ‘professionally-oriented’ variants. The HEQSF also specifies the purpose and characteristics of each qualification type. However, as indicated in the *Framework for Qualification Standards in Higher Education* (CHE, 2013), neither NQF level descriptors nor the HEQSF is intended to address, or indeed capable of addressing, fully the relationship between generic qualification-type purpose and the specific characteristics of that qualification type in a particular field of study. One of the tasks of standards development is to reconcile the broad, generic description of a qualification type according to the HEQSF and the particular characteristics of qualifications awarded in diverse fields of study and disciplines, as defined by various descriptors and qualifiers.

Development of qualification standards is guided by the principles, protocols and methodology outlined in the *Framework*, approved by the Council in March 2013. The focus of a standards statement is the relationship between the purpose of the qualification, the attributes of a graduate that manifest the purpose, and the contexts and conditions for assessment of those attributes. A standard establishes a threshold. However, on the grounds that a standard also plays a developmental role, the statement may include, as appropriate, elaboration of terms specific to the statement, guidelines for achievement of the graduate attributes, and recommendations for above-threshold practice.

The drafting of this standards statement is the work of a consultant recommended, and endorsed, by a group of academic experts in the field of study, convened by the CHE and comprising Deans of Engineering or their nominees. The draft standard was presented to a meeting of Engineering Deans held on 18th May 2016. The standard was endorsed by the meeting, subject to minor amendment. On recommendation by the meeting, the draft was submitted, via the Engineering Council of South Africa (ECSA) to its Engineering Standards Generating Body, for comment. Comments from ECSA were received on 21 November 2106, and where appropriate have been incorporated into the draft.

The CHE disseminates the draft standard for the consideration of all relevant and interested parties. Comments received by the CHE are referred, as appropriate, to the Engineering Deans for consideration. When all issues have been considered and reconciled, the Directorate: National Standards and Reviews submits to the Council a standards statement for approval.

DRAFT FOR PUBLIC COMMENT

QUALIFICATION TYPE AND VARIANT

Bachelor's degree (*Professional*)

GENERAL CHARACTERISTICS

There are two types of Bachelor's Degrees, namely general and professionally-oriented Bachelor's Degrees. Both types of degree may be structured as a 360-credit qualification with an exit at level 7 or as a 480-credit qualification with an exit at level 8 on the National Qualifications Framework....The 480-credit Bachelor's Degree at NQF level 8 has both a higher volume of learning and a greater cognitive demand than the 360-credit degree at level 7 and should prepare students to be able to undertake Master's level study by providing them with research capacity in the methodology and research techniques of the discipline.

The primary purpose of both the general and the professional Bachelor's Degree is to provide a well-rounded, broad education that equips graduates with the knowledge base, theory and methodology of disciplines and fields of study, and to enable them to demonstrate initiative and responsibility in an academic or professional context. Both the 360- and 480-credit Bachelor's Degrees may require students to undertake research in a manner that is appropriate to the discipline or field of study in order to prepare them for postgraduate study.

...The professional Bachelor's Degree prepares students for professional training, post-graduate studies or professional practice in a wide range of careers. Therefore it emphasises general principles and theory in conjunction with procedural knowledge in order to provide students with a thorough grounding in the knowledge, theory, principles and skills of the profession or career concerned and the ability to apply these to professional or career contexts. The degree programme may contain a component of work-integrated learning.

(The Higher Education Qualifications Sub-Framework, CHE, 2013)

STANDARD FOR THE BACHELOR OF ENGINEERING TECHNOLOGY

Preamble

The competence of an engineering technologist at the level required for independent practice, that is, on qualifying for professional registration as a Professional Engineering Technologist, is generally developed in two stages. First, an educational foundation is acquired through higher education. Second, competence must be further developed through training and experience, typically for four or more years after graduation. The Bachelor of Engineering Technology delivered to this standard provides the educational foundation.

A profile of the Professional Engineering Technologist is given in section 11.2.

The role of the engineering technologist is to apply existing and emerging technologies, usually in an engineering sub-discipline, to meeting requirements of enterprises, governments and people. The educational foundation of the engineering technologist has a fundamental base in an engineering sub-discipline together with knowledge in particular areas of application. The engineering technologist must take into account the context and impacts of solutions and manage engineering processes.

As indicated in the qualification title definition below, the qualification may be awarded on completion of programmes in one of several sub-disciplines, engineering technologies or cross-disciplinary fields, including newly-emerged fields. This standard specifies the generic knowledge profile and outcomes common to all programmes. Standards are not defined at the qualifier level.

Note

Words and phrases having specific meaning are defined in section 11 of this document or in ECSA Document E-01-P. The method recommended for calculating credits is detailed in ECSA document E-01-P available at www.ecsa.co.za.

1. HEQSF Specification

HEQSF Qualification Type	Bachelor Degree	
Variant	Professionally-oriented	
NQF Exit Level	Total Minimum Credits	Minimum Credits at Exit Level
7	420	120

2. Qualification Title

Designator: Bachelor of Engineering Technology

Qualifiers: A single qualifier should be used and may take the form of a sub-discipline or specialist field, for example Structural, Transportation, Building Services, Clinical, Electronic, Digital Systems, followed by the word Engineering. For example:

Bachelor of Engineering Technology in Structural Engineering

Bachelor of Engineering Technology in Electric Power Engineering

3. Purpose Statement

The primary purpose of this qualification is to develop a knowledge base that supports the graduate, who after graduation undertakes training and experience, attains mastery of specific engineering technologies and their application. Such knowledge and skill constitute the educational foundation for an engineering technologist. Specialist knowledge is underpinned by engineering fundamentals in at least an engineering sub-discipline. Engineering knowledge is in turn underpinned by natural science principles and mathematical methods. The application of specialist knowledge is informed by knowledge of the context and impacts of technology application.

Note: *This standard is designed to meet the educational requirement towards registration as a Candidate or Professional Engineering Technologist with the Engineering Council of South Africa.*

4. Normal duration of study

Programmes have a normal duration of three years of full-time study, with not less than 420 credits.

5. Standard for the award of the qualification

The purpose and level of the qualification will have been achieved when the student has demonstrated:

- the knowledge defined in section 6; and
- the skills and applied competence defined in section 7.

6. Knowledge

Knowledge demonstrated by the graduate has the following characteristics:

6.1: At least the number of credits in the knowledge areas shown:

Knowledge Area	Minimum Credits
Mathematical Sciences	42
Natural Sciences	28
Engineering Sciences	140
Engineering Design & Synthesis	49
Computing and Information Technology	21
Complementary Studies	28

Note: *These credits total 308. Credits in selected knowledge areas must be increased to satisfy the 420 minimum total credits, while satisfying 6.2, 6.3 and 6.4 below.*

6.2: A coherent core of mathematical sciences, natural sciences and engineering sciences that supports learning and application of specialist engineering and engineering technologies, both in the curriculum and on a lifelong basis.

6.3 Knowledge in the various areas has the following characteristics:

1. A knowledge of mathematics that uses formalism and is oriented toward engineering analysis and modelling;
2. A fundamental knowledge of natural science relevant to a sub-discipline or recognised practice area.
3. A coherent range of fundamental principles in engineering science and technology underlying an engineering sub-discipline or recognised practice area.
4. A systematic body of established and emerging knowledge in a specialist or recognized practice area.

6.3: Complementary studies supporting both a broadening of the graduate's perspective on the world in which he or she will practice and enabling of engineering technology work including economics, impacts of technology on the environment and society, and effective communication.

6.4: This qualification does not specify detailed curriculum content. The fundamental and specialist engineering science content must be consistent with the designation of the qualification.

7. Skills and Applied Competence

The graduate is able to demonstrate attributes 1 to 10:

1: Problem Solving

Apply engineering principles to systematically analyse and solve *broadly-defined* engineering problems.

Level Descriptor: *Broadly-defined engineering problems:*

- a. require coherent and detailed engineering knowledge underpinning the technologies being applied;

and have one or more of the characteristics:

- b. are ill-posed, or under- or over-specified, requiring identification and interpretation in the technology area;
- c. encompass systems within complex engineering systems;
- d. belong to families of problems which are solved in well-accepted but innovative ways;

and have one or more of the characteristics:

- e. can be solved by structured analysis techniques;
- f. may be partially outside standards and codes; operating outside standards and codes must be justified;
- g. require information from sources in the practice area and interfacing with the practice area; information may be incomplete;
- h. involve a variety of issues which may impose conflicting needs and constraints: technical, engineering and interested or affected parties.

2: Application of scientific and engineering knowledge

Apply knowledge of mathematics, natural science and engineering sciences to defined, applied engineering procedures, processes, systems and methodologies to solve *broadly-defined* engineering problems.

Range Statement: See Section 6.

3: Engineering Design

Perform procedural and non-procedural design of components, systems, works, products or processes to meet desired needs.

Level descriptor: Design problems used in assessment must conform to the definition of *broadly-defined* engineering problems given in Attribute 1.

Range Statement:

1. A major design project must be used to provide a body of evidence that demonstrates this outcome.
2. The project would be typical of that in which the graduate would participate in a typical employment situation shortly after graduation.
3. The problem is normally addressed within applicable standards, codes of practice and legislation.

4. The selection of components, systems, engineering works, products or processes to be designed is dependent on the sub-discipline.
5. A major design project should include consideration of one or more of the following impacts: social, economic, legal, health- and/or safety-related, and environmental.

4: Investigation

Conduct investigations of *broadly-defined* problems through locating, searching and selecting relevant data from codes, data bases and literature, designing and conducting experiments, analysing and interpreting results to provide valid conclusions.

Range Statement: The balance of investigation and experiment should be appropriate to the discipline. An investigation or experimental study should be typical of those in which the graduate would participate in an employment situation shortly after graduation.

5: Engineering methods, skills, tools, including Information technology

Use appropriate techniques, resources, and modern engineering tools, and information technology, including prediction and modelling, for the solution of *broadly-defined* engineering problems, with an understanding of their limitations, restrictions, premises, assumptions and constraints.

Range Statement: A range of methods, skills and tools appropriate to the sub-discipline of the program including:

1. Tools, processes or procedures specific to the technology applied or practice area.
2. Computer packages for computation, modelling, simulation, and information handling;
3. Computers and networks and information infra-structures for accessing, processing, managing, and storing information to enhance personal productivity and teamwork;
4. Techniques from economics, management, and health, safety and environmental protection.

6: Professional and Technical Communication

Communicate effectively, both orally and in writing, with engineering audiences and the parties affected by engineering activity.

Range Statement: A range of contexts and forms of communication including:

1. Material to be communicated arises in an academic or simulated professional context. Audiences range from engineering peers, related engineering personnel and lay persons. Academic or professional discourse appropriate to the purpose is used.
2. Written reports range from short (300-1000 words plus tables and diagrams) to long (10 000 to 15 000 words plus tables, diagrams and appendices), covering material at the exit level.
3. Methods of providing information include the conventional methods of the discipline, for example engineering drawings, as well as subject-specific methods.

7: Impact of Engineering Activity

Demonstrate knowledge and understanding of the impact of engineering activity on society, the economy, the industrial and physical environments, addressing issues by analysis and evaluation.

Range Statement: The combination of social, workplace (industrial) and physical environmental factors must be appropriate to the sub-discipline of the qualification. Evidence may include case

studies typical of the technological practice situations in which the graduate is likely to participate. Issues and impacts to be addressed:

1. Are generally within, but may be partially outside of, standards and code of practice
2. Involve several groups of stakeholders with differing and conflicting needs.
3. Have consequences that are locally important but may extend more widely.
4. May be part of, or a system within, a wider engineering system.

8: Management and Teamwork

Demonstrate knowledge and understanding of engineering management principles and apply these to one's own work, as a member and leader in a team, and to manage projects.

Range Statement:

1. The ability to manage a project should be demonstrated in a project of the form indicated in Attribute 3.
2. Tasks are discipline-specific and within the technical competence of the graduate.
3. Management principles include:
 - a. Planning: set objectives, select strategies, implement strategies and review achievement.
 - b. Organising: set operational model, identify and assign tasks, identify inputs, delegate responsibility and authority.
 - c. Leading: give directions, set example, communicate, motivate.
 - d. Controlling: monitor performance, check against standards, identify variations and take remedial action.

9: Independent Learning

Capacity to engage in independent and life-long learning through well-developed learning skills.

Range Statement: The learning context is varying and unfamiliar. Some information is drawn from the technological literature.

10: Engineering Professionalism

Comprehend and apply ethical principles and commit to professional ethics and the responsibilities and norms of engineering technology practice.

Range Statement: Evidence includes case studies typical of engineering practice situations in which the graduate is likely to participate.

8. Contexts and Conditions for Assessment

Graduate attributes defined above are stated generically and may be assessed in an engineering sub-disciplinary or cross-disciplinary context in a provider-based or simulated workplace environment.

9. Award of the Qualification

The qualification may be awarded when the qualification standard has been **met or exceeded**.

10. Progression

Providers may design programmes to enable academic progression from this three year professional bachelors degree to Bachelor Honours programmes or to Bachelor of Engineering programmes, giving access to higher degrees. A qualification may not be awarded for early exit from a Bachelor's degree. Graduates holding this qualification may also meet requirements for:

1. Entry to a candidacy programme toward registration as a Professional Engineering Technologist;
2. Subject to approval by the relevant Chief Inspector, progression toward admission to the Government Certificate of Competency examinations in particular disciplines. (See Section 11.5.)

11. Guidelines

11.1 Pathway

This qualification lies on a HEQSF professional pathway.

11.2 Profile of a Professional Engineering Technologist

Professional Engineering Technologists are characterized by the ability to apply established and newly developed engineering technology to solve *broadly-defined* engineering problems; they develop components, systems, services and processes.

They provide leadership in the application of technology in safety, health, engineering and commercially effective operations and have well-developed interpersonal skills.

They work independently and responsibly, applying judgement to decisions arising in the application of technology and health and safety considerations to problems and associated risks.

Professional Engineering Technologists have a specialized understanding of engineering sciences underlying a deep knowledge of specific technologies together with financial, commercial, legal, social and economic, health, safety and environmental matters.

11.3 Definition of terms

Complementary Studies: cover those disciplines outside of engineering sciences, natural sciences and mathematics which are relevant to the practice of engineering including but not limited to engineering economics, management, the impact of technology on society, effective communication, and the humanities, social sciences or other areas that support an understanding of the world in which engineering is practised.

Engineering Discipline (= Branch of engineering): a generally-recognised, major subdivision of engineering such as the traditional disciplines of Chemical, Civil, or Electrical Engineering, or a cross-disciplinary field of comparable breadth including combinations of engineering fields, for example Mechatronics, and the application of engineering in other fields, for example Bio-Medical Engineering.

Engineering Sub-discipline: a generally-recognised practice area or major subdivision within an engineering discipline, for example Structural and Geotechnical Engineering within Civil Engineering.

Engineering Fundamentals: engineering sciences that embody a systematic formulation of engineering concepts and principles based on mathematical and natural sciences to support applications.

Engineering Management: the generic management functions of planning, organising, leading and controlling, applied together with engineering knowledge in contexts including the management of projects, construction, operations, maintenance, quality, risk, change and business.

Engineering Design and Synthesis: is the systematic process of conceiving and developing materials, components, systems and processes to serve useful purposes. Design may be procedural, creative or open-ended and requires application of engineering sciences, working under constraints, and taking into account economic, health and safety, social and environmental factors, codes of practice and applicable laws.

Engineering Sciences: have roots in the mathematical and physical sciences, and where applicable, in other natural sciences but extend knowledge and develop models and methods in order to lead to engineering applications and solve engineering problems.

Engineering Speciality: the extension of engineering fundamentals to create theoretical frameworks and bodies of knowledge for engineering practice areas.

Mathematical Sciences: an umbrella term embracing the techniques of mathematics, numerical analysis, statistics and aspects of computer science cast in an appropriate mathematical formalism.

Natural Sciences: physics (including mechanics), chemistry, earth sciences and the biological sciences which focus on understanding the physical world, as applicable in each engineering disciplinary context.

11.4 International comparability of this qualification

While this qualification has not been formally approved for recognition of accredited programmes under the Sydney Accord, its outcomes are modelled on the Sydney Accord Graduate Attributes.

11.5 Possible Role of the Qualification for Certificated Engineers

The Certificated Engineer is a title granted under the Occupational Health and Safety Act (OHSA) (Act 85 of 1993 amended by Act 181 of 1993); the Mines Health and Safety Act (MHSA) (Act 27 of 1996 as amended) or the Merchant Shipping Act, 1951 (Act No. 57 of 1951). The title and licence to undertake prescribed responsibilities is conferred through a Government Certificate of Competency (GCC) examination conducted for each type of GCC. This qualification may be recognised by the Chief Inspector of the relevant government department as an entry requirement to the GCC examination. While the engineering competencies specified by the knowledge in section 6 and the outcomes in Section 7 are common to the engineering technologist and certificated engineer, specific knowledge may be prescribed by the relevant Chief Inspector for each form of GCC. Programmes accredited by ECSA as meeting this qualification standard and incorporating specific knowledge prescribed for the relevant GCC may qualify the holder to enter the GCC examination. The entry requirement for registration as a Candidate Certificated Engineer with ECSA is a GCC.

ANNEXURE A

NQF LEVEL DESCRIPTORS

The qualification is awarded at **level 7** on the National Qualifications Framework (NQF) and therefore meets the following level descriptors:

- a. Scope of knowledge, in respect of which a learner is able to demonstrate integrated knowledge of the central areas of one or more fields, disciplines or practices, including an understanding of and the ability to apply and evaluate the key terms, concepts, facts, principles, rules and theories of that field, discipline or practice; and detailed knowledge of an area or areas of specialisation and how that knowledge relates to other fields, disciplines or practices.
- b. Knowledge literacy, in respect of which a learner is able to demonstrate an understanding of knowledge as contested and the ability to evaluate types of knowledge and explanations typical within the area of study or practice.
- c. Method and procedure, in respect of which a learner is able to demonstrate an understanding of a range of methods of enquiry in a field, discipline or practice, and their suitability to specific investigations; and the ability to select and apply a range of methods to resolve problems or introduce change within a practice.
- d. Problem solving, in respect of which a learner is able to demonstrate the ability to identify, analyse, evaluate, critically reflect on and address complex problems, applying evidence-based solutions and theory-driven arguments.
- e. Ethics and professional practice, in respect of which a learner is able to demonstrate the ability to take decisions and act ethically and professionally, and the ability to justify those decisions and actions drawing on appropriate ethical values and approaches within a supported environment.
- f. Accessing, processing and managing information, in respect of which a learner is able to demonstrate the ability to develop appropriate processes of information gathering for a given context or use; and the ability to independently validate the sources of information and evaluate and manage the information.
- g. Producing and communicating information, in respect of which a learner is able to demonstrate the ability to develop and communicate his or her ideas and opinions in well-formed arguments, using appropriate academic, professional, or occupational discourse.
- h. Context and systems, in respect of which a learner is able to demonstrate the ability to manage processes in unfamiliar and variable contexts, recognising that problem solving is context and system bound, and does not occur in isolation.
- i. Management of learning, in respect of which a learner is able to demonstrate the ability to identify, evaluate and address his or her learning needs in a self-directed manner, and to facilitate collaborative learning processes.
- j. Accountability, in respect of which a learner is able to demonstrate the ability to take full responsibility for his or her work, decision-making and use of resources, and limited accountability for the decisions and actions of others in varied or ill-defined contexts.