ENGINEERING COUNCIL OF SOUTH AFRICA *Standards and Procedures System*			ECSA
Qualification Standard for Bachelor of Science in Engineering (BSc(Eng))/ Bachelors of Engineering (BEng): NQF Level 8			
Status: For Approval by EPAC and Council			
Document : E-02-PE	**Rev-3 Draft E**	**21 June 2012**	

Background: The ECSA Education System Documents

The documents that define the Engineering Council of South Africa (ECSA) system for accreditation of programmes meeting educational requirements for professional categories are shown in Figure 1 which also locates the current document.

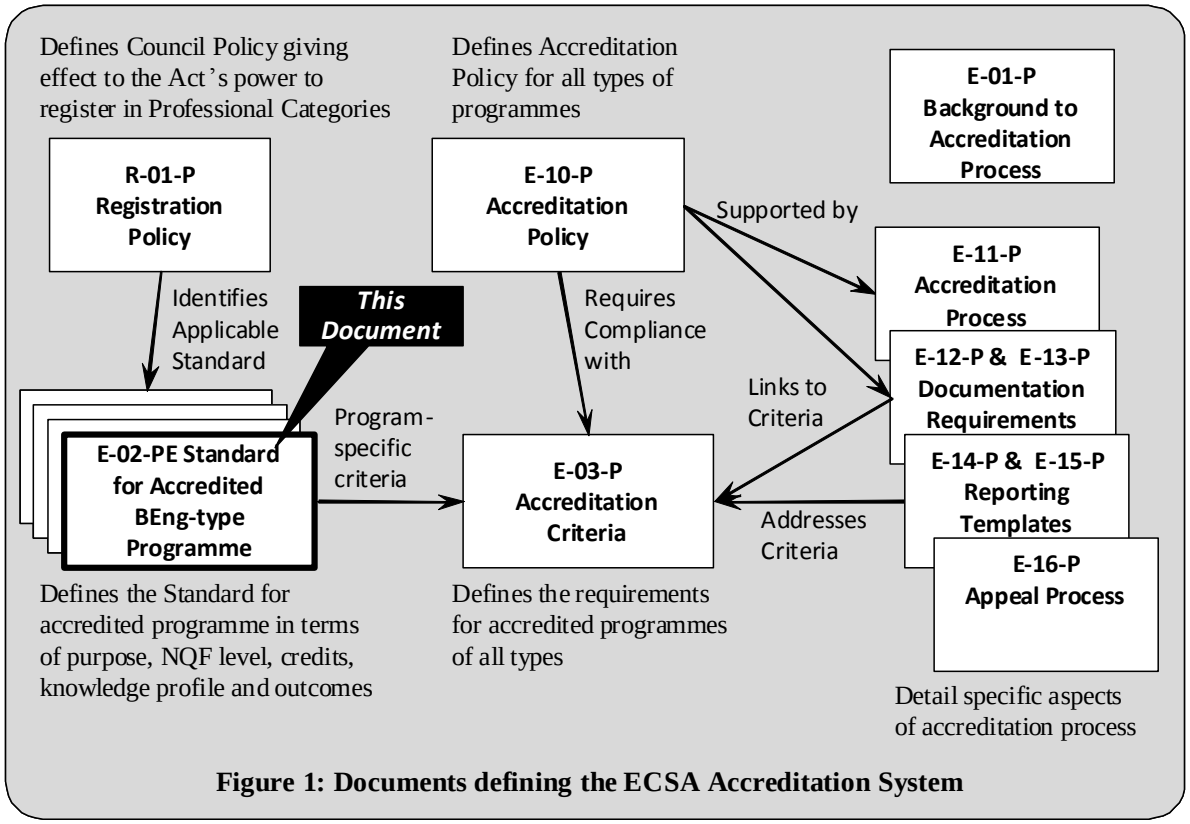

Figure 1: Documents defining the ECSA Accreditation System

1. Purpose

This document defines the standard for accredited Bachelor of Engineering-type programmes in terms of programme design criteria, a knowledge profile and a set of exit level outcomes. This standard is referred to in the Accreditation Criteria defined in ECSA document E-03-P.

2. Field

Manufacturing, Engineering and Technology

3. Subfield

Engineering and Related Design

4. NQF Exit Level

Level 8

5. Credits

560 credits total. Not less than 120 Credits must be at NQF level 8.

6. Acceptable Titles

Bachelor of Engineering, Bachelor of Science in Engineering, Baccalareus Ingeneriae.

7. Abbreviations

BEng, BSc(Eng), BIng.

8. Qualifiers

The qualification must have a disciplinary or cross-disciplinary qualifier (discipline, branch, option or endorsement) defined in the provider's rules for the degree that is reflected on the academic transcript and degree certificate, subject to the following:

1. There must be at least one qualifier which contains the word Engineering together with a disciplinary description such as: Agricultural, Aeronautical, Chemical, Civil, Computer, Electrical, Electro-mechanical, Electronic, Environmental, Industrial, Extractive Metallurgical, Information, Materials, Mechanical, Mechatronic, Metallurgical, Mineral(s) Process, Physical Metallurgical and Mining. Qualifiers are not restricted to this list.
2. The qualifier(s) must clearly indicate the nature and purpose of the programme.
3. The qualifier must be consistent with the fundamental engineering science content on the programme.
4. The qualifier(s) should be comparable with typical programmes within Washington Accord countries;
5. The target market indicated by the qualifier may be a traditional branch of engineering or a substantial industry area. Programmes should not address narrow niche markets. Formal education for such markets should rather be satisfied by broad undergraduate programmes such as specified in this standard followed by specialized course-based postgraduate programmes.

In the case of a provider offering programmes with the same first-level qualifier and different second-level qualifiers but with insufficiently differentiated purpose or content, only one programme should be accredited.

Examples of acceptable designations in accordance with HEQF policy are:

Bachelor of Engineering in Civil Engineering, abbreviated BEng (Civil Engineering)
Bachelor of Engineering in Civil Engineering in Environmental Engineering abbreviated BEng(Civil Engineering)(Environmental Engineering)

9. Purpose of the Qualification

The purpose of the qualification is to build the necessary knowledge, understanding, abilities and skills required for further learning towards becoming a competent practicing engineer. The recognised purpose of this bachelors degree in engineering, accredited as satisfying this standard is to provide graduates with:

1. Preparation for careers in engineering and related areas, for achieving technical leadership and to make a contribution to the economy and national development;
2. The educational requirement towards registration as a Professional Engineer with the Engineering Council of South Africa as well as to allow the graduate to make careers in engineering and related fields;
3. A thorough grounding in mathematics, natural sciences, engineering sciences, engineering modelling, engineering design and the abilities to enable applications in fields of emerging

knowledge together with an appreciation for the world and society in which engineering is practised;

4. For graduates with an appropriate level of achievement in the programme, the ability to proceed to postgraduate studies in both course-based and research masters programmes.

10. Programme Structure

Subject to the overall requirement for a minimum of 560 credits determined using the method defined in document R-01-P with not less than 120 credits at NQF level 8, credits must be distributed in order to create a coherent progression of learning towards the exit-level. Preparatory or remedial courses are not included in the 560 credits.

10.1 Knowledge Profile of the Graduate

The content of the programme when analysed by knowledge area must not fall below the minimum SAQA credits in each knowledge area in table 1.

Knowledge areas are defined in document E-01-P. The method for calculating credits and allocating to knowledge areas is defined in document E-01-P.

Table 1: Minimum curriculum content by knowledge area

Knowledge area	Minimum Credits
Mathematical Sciences	56
Natural Sciences	56
Engineering Sciences	180
Design and Synthesis	72
Complementary studies	56
Subtotal	420
For Reallocation	≥140
Total Credits	≥560

The *for reallocation* component must be taken up by allocating knowledge to the five knowledge areas, to form a coherent, balanced programme.

If the provider includes work-based learning in the programme, credits may be assigned and included in the knowledge breakdown only if the work is quality assured by the provider, student's performance is comprehensively assessed against defined outcomes and is this information is documented and presented in the accreditation process.

The knowledge profile is expanded in Exit Level outcomes 2 and 7.

10.2 Core and Specialist Requirements

The programme must have a coherent core of mathematics, natural sciences and engineering fundamentals that provides a viable platform for further studies and lifelong learning. The coherent core must enable development in a traditional discipline or in an emerging field.

A programme must contain specialist engineering study at the exit-level. Specialist study may take on many forms including further deepening of a theme in the core, a new sub-discipline, or a specialist topic building on the core. It is recognized that the extent of specialist study is of necessity limited in view of the need to provide a substantial coherent core. Specialist study may take the form of compulsory or elective credits.

In the Complementary Studies area, the programme is expected to contain material under both parts (a) and (b) of the definition in document E-01-P. Complementary Studies knowledge of type (b) must be sufficient and appropriate to support the student in satisfying Exit Level Outcomes 7 and 10.

10.3 Curriculum Content

This standard does not specify detailed curriculum content. The engineering fundamentals and specialist engineering science content must be consistent with the designation of the degree.

11. Access to Qualification

This standard is specified as a set of exit-level outcomes and overall distribution of credits. Providers therefore have freedom to construct programmes geared to different levels of preparedness of learners, including:

- Use of access programmes for learners who do not meet the minimum learning requirements;
- Creating articulation paths from other qualifications.

12. Minimum Learning Assumed to be in Place

Designers of a 560 credit programme to meet the exit-level outcomes and credit requirements defined in this standard assume that entrants are proficient as specified by the provider's entry requirements in Mathematics, Physical Science and reading, speaking and writing in the language of teaching and learning, and reading in English.

Note: These assumptions do not prescribe prerequisites. Sections 11 and 12 should be read together.

13. Exit Level Outcomes

Exit level outcomes defined below are stated generically and may be assessed in various engineering disciplinary or cross-disciplinary contexts in a provider-based or simulate practice environment. Words and phrases having specific meaning are defined in this document or in ECSA Document E-01-P [1].

General Range Statement: The competencies defined in the ten exit-level outcomes may be demonstrated in a university-based, simulated workplace context. Competencies stated generically may be assessed in various engineering disciplinary or cross-disciplinary contexts.

Exit-level Outcome 1: Problem solving

Identify, formulate, analyse and solve complex engineering problems creatively and innovatively.

***Level Descriptor: Complex Engineering Problems**:*

a) require in-depth fundamental and specialized engineering knowledge;
and have one or more of the characteristics:
b) are ill-posed, under- or overspecified, or require identification and refinement;
c) are high-level problems including component parts or sub-problems;
d) are unfamiliar or involve infrequently encountered issues;
and their solution have one or more of the characteristics:
e) are not obvious, require originality or analysis based on fundamentals;
f) are outside the scope of standards and codes;
g) require information from variety of sources that is complex, abstract or incomplete;
h) involve wide-ranging or conflicting issues: technical, engineering and interested or affected parties.

Exit-level Outcome 2: Application of scientific and engineering knowledge

Apply knowledge of mathematics, natural sciences, engineering fundamentals and an engineering speciality to solve complex engineering problems.

Level descriptor: Knowledge of mathematics, natural sciences and engineering sciences is characterized by:

- A systematic, theory-based understanding of the natural sciences applicable to the discipline;
- Conceptually-based mathematics, numerical analysis, statistics and formal aspects of computer and information science to support analysis and modelling applicable to the discipline;
- A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline;
- engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline.

Mathematics, natural science and engineering sciences are applied in formal analysis and modelling of engineering situations, and for reasoning about and conceptualizing engineering problems.

Exit-level Outcome 3: Engineering Design

Perform creative, procedural and non-procedural design and synthesis of components, systems, engineering works, products or processes.

Range Statement: Design problems used in exit-level assessment must conform to the definition of a complex engineering problem, defined under Exit-level Outcome 1. A major design problem should be used to provide evidence. The design knowledge base and components, systems, engineering works, products or processes to be designed are dependent on the discipline or practice area.

Exit-level Outcome 4: Investigations, experiments and data analysis

Demonstrate competence to design and conduct investigations and experiments.

Range Statement: The balance of investigation and experiment should be appropriate to the discipline. Research methodology to be applied in research or investigation where the student engages with selected knowledge in the research literature of the discipline.

Note: An investigation differs from a design in that the objective is to produce knowledge and understanding of a phenomenon and a recommended course of action rather than specifying how an artifact could be produced.

Exit-level Outcome 5: Engineering methods, skills and tools, including Information Technology

Demonstrate competence to use appropriate engineering methods, skills and tools, including those based on information technology.

Range Statement: A range of methods, skills and tools appropriate to the disciplinary designation of the program including:

1. Discipline-specific tools, processes or procedures;
2. Computer packages for computation, modelling, simulation, and information handling;
3. Computers and networks and information infrastructures for accessing, processing, managing, and storing information to enhance personal productivity and teamwork;
4. Basic techniques from economics, business management;
5. Health, safety and environmental protection appropriate to the discipline;
6. Risk assessment and management;
7. Project management.

Exit-level Outcome 6: Professional and technical communication

Demonstrate competence to communicate effectively, both orally and in writing, with engineering audiences and the community at large.

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

Exit-level Outcome 7: Impact of Engineering Activity

Demonstrate critical awareness of the impact of engineering activity on the social, industrial and physical environment.

Range Statement: The combination of social, workplace (industrial) and physical environmental factors must be appropriate to the discipline or other designation of the qualification. Comprehension of the role of engineering in society and identified issues in engineering practice in the discipline: ethics and the professional responsibility of an engineer to public safety; the impacts of engineering activity: economic, social, cultural, environmental and sustainability

Exit-level Outcome 8: Individual, Team and Multidisciplinary Working

Demonstrate competence to work effectively as an individual, in teams and in multidisciplinary environments.

Range Statement: Multidisciplinary tasks require co-operation across at least one disciplinary boundary. Co-operating disciplines may be engineering disciplines with different fundamental bases other than that of the programme or may be outside engineering.

Exit-level Outcome 9: Independent Learning Ability

Demonstrate competence to engage in independent learning through well developed learning skills.

Range Statement: Operate independently in complex, ill-defined contexts requiring personal responsibility and initiative, accurately self-evaluate and take responsibility for learning requirements; be aware of social and ethical implications of applying knowledge in particular contexts.

Exit-level Outcome 10: Engineering Professionalism

Demonstrate critical awareness of the need to act professionally and ethically and to exercise judgment and take responsibility within own limits of competence.

Range Statement: Evidence includes case studies typical of engineering practice situations in which the graduate is likely to participate. The contextual knowledge profile specified in the range statement of Exit Level outcome 7 is applicable here.

14. International Comparability

International comparability of the whole qualification standard is ensured through the Washington Accord. The standards are comparable with those for professionally-oriented bachelors degrees in engineering in countries having comparable engineering education systems to South Africa: Australia, Canada, Chinese Taipei, Hong Kong China, Ireland, Japan, Republic of Korea, Malaysia, Russia, New Zealand, Singapore, Turkey, United Kingdom, and the United States of America[1]. Comparability is audited on a six-yearly cycle by a visiting Washington Accord team.

15. Integrated Assessment

Providers of programmes must demonstrate in the quality assurance process that an effective integrated assessment strategy is used. Clearly identified components of assessment must address

[1] List as at July 2012. The current signatories can be found on http://www.ieagreements.org.

summative assessment of the exit-level outcomes. Evidence should be derived from major work or multiple instances of limited scale work.

16. Recognition of Prior Learning

Providers may make use of recognition of prior learning at intermediate levels but must take full responsibility for assessing the exit-level outcomes.

17. Articulation Possibilities

The exit-level outcomes ensure that a graduate of a programme meeting these standards would meet requirements for entry to a number of programmes including:

1. A candidacy programme toward registration as a Professional Engineer
2. Formal specialist study toward the Postgraduate Diplomas;
3. A postgraduate Bachelor of Laws (LLB) programme;
4. Specialist coursework masters programmes;
5. Research masters programmes leading to masters degrees with or without coursework components;
6. With appropriate work experience, a Master of Business Administration or similar;
7. In certain disciplines, progression toward the Government Certificate of Competency.

18. Moderation and Registration of Assessors

Providers of programmes must demonstrate in the quality assurance process that an effective moderation process exists to ensure that the assessment system is consistent and fair.

Registration of assessors is delegated by the Higher Education Quality Committee to the Higher Education providers responsible for programmes.

References

1. Background to Accreditation of Engineering Education Programmes, Document E-01-P. Available via www.ecsa.co.za.

Appendix A: Consistency of Exit Level Outcomes with Critical Crossfield Outcomes

SAQA Critical Cross-Field Outcomes	Equivalent Exit Level Outcome
Identifying and solving problems in which responses display that responsible decisions using critical thinking have been made.	ELO 1, 2, 3, 5
Working effectively with others as a member of a team, group, organization and community.	ELO 8
Organising and managing oneself and one's activities responsibly and effectively	ELO 8
Collecting, analyzing, organizing and critically evaluating information.	ELO 1, 3, 5
Communicating effectively using visual, mathematical and/or language skills	ELO 2, 6
Using science and technology effectively and critically, showing responsibility toward the environment and health of others	ELO 2, 3, 4, 5, 7
Demonstrating an understanding of the world as a set of related systems by recognizing that problem contexts do not exist in isolation	ELO 1, 3,
Contributing to the full personal development of each learner and the social and economic development of society at large, by making it an underlying intention of the programme of learning to make an individual aware of:	
• reflecting on and exploring a variety of strategies to learn more effectively	ELO 9
• participating as responsible citizens in the life of local, national and global communities	ELO 10
• being culturally and aesthetically sensitive across a range of contexts	ELO 7
• exploring education and career opportunities	ELO 8
• Developing entrepreneurial opportunities	ELO 3

Revision History

Version	Date	Revision authorised by	Nature of revision
Revision - 0	16 April 1998	Council	Initial Issue
Rev-1/Draft-A	20 July 2000	UAC: Recommended to Council	Change to SAQA Credit (3.1) Editorial changes
Rev-1	11 Aug 2000	Council	Put into PDF format
Revision-2	26 July 2004	Council, approved by SAQA, registered on NQF	Clarified outcome, SAQA elements added
Revision 2.1	19 Jan 2007	Acc Policy WG	Identifier changed from PE-61 to E-02-PE
Revision 3/Draft A	11 July 2007	ESGB activates SGG	Working paper for SGG Meeting 24 Oct 2007
Revision 3/Draft B	25 Oct 2007	BEng SGG	Incorporates changes approved by SGG For confirmation by SGG
Revision 3/Draft C	15 Sep 2011	EPAC	HEQF Alignment, Assessment criteria changed to informative, Graduate Attribute Alignment

Revision 3/Draft D	22Feb 2012	EPAC and ESGB	Corrections and expansion of explanatory notes for circulation to stakeholders.
Revision 3/Draft E	21 June 2012	For Submission to EPAC and Council	